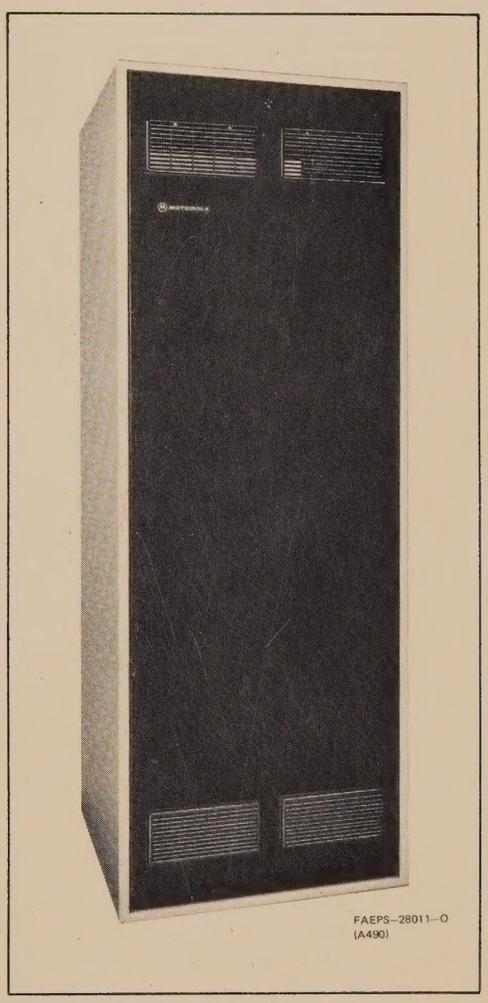
MOTOROLA

PULSAR™

IMTS Base Stations

150.8-160 MHz
40-100 Watts
DC and Tone Control Models



FAEPS-28011-O
(A490)

Instruction Manual

68P81033E15-A

COMMERCIAL WARRANTY
(STANDARD)

Motorola radio communications products are warranted to be free from defects in material and workmanship for a period of ONE (1) YEAR, (except for crystals and channel elements which are warranted for a period of ten (10) years) from the date of shipment. Parts, including crystals and channel elements, will be replaced free of charge for the full warranty period but the labor to replace defective parts will only be provided for One Hundred-Twenty (120) days from the date of shipment. Thereafter purchaser must pay for the labor involved in repairing the product or replacing the parts at the prevailing rates together with any transportation charges to or from the place where warranty service is provided. This express warranty is extended by Motorola Communications and Electronics, Inc., 1301 E. Algonquin Road, Schaumburg, Illinois 60196, to the original purchaser only, and only to those purchasing for purpose of leasing or solely for commercial, industrial, or governmental use.

THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED WHICH ARE SPECIFICALLY EXCLUDED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW.

In the event of a defect, malfunction or failure to conform to specifications established by seller, or if appropriate, to specifications accepted by Seller in writing, during the period shown, Motorola, at its option, will either repair or replace the product or refund the purchase price thereof, and such action on the part of Motorola shall be the full extent of Motorola's liability hereunder.

This warranty is void if:

a. the product is used in other than its normal and customary manner;
b. the product has been subject to misuse, accident, neglect or damage;
c. unauthorized alterations or repairs have been made, or unapproved parts used in the equipment.

This warranty extends only to individual products, batteries are excluded, but carry their own separate limited warranty. Because each radio system is unique, Motorola disclaims liability for range, coverage, or operation of the system as a whole under this warranty except by a separate written agreement signed by an officer of Motorola.

Non-Motorola manufactured products are excluded from this warranty, but subject to the warranty provided by their manufacturers, a copy of which will be supplied to you on specific written request.

In order to obtain performance of this warranty, purchaser must contact its Motorola salesperson or Motorola at the address first above shown, attention Quality Assurance Department.

This warranty applies only within the United States.

EPS-27734-O

COMPUTER SOFTWARE COPYRIGHTS

The Motorola products described in this instruction manual may include copyrighted Motorola computer programs stored in semiconductor memories or other mediums. Laws in the United States and other countries preserve for Motorola certain exclusive rights for copyrighted computer programs, including the exclusive right to copy or reproduce in any form the copyrighted computer program. Accordingly, any copyrighted Motorola computer programs contained in the Motorola products described in this instruction manual may not be copied or reproduced in any manner without the express written permission of Motorola. Furthermore, the purchase of Motorola products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Motorola, except for the normal non-exclusive, royalty free license to use that arises by operation of law in the sale of a product.

EPS-34440-A

68P81112E94-A

MOTOROLA INC.

instruction manual revision

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

The following instruction manuals are affected by this revision:

68P81013E60	25-50 MHZ *Micor Compa Station* Manual
68P81013E65	132-174 MHZ *Micor Compa Station* Manual
68P81013E70	25-50 MHZ *Micor Compa Station* Manual
68P81025E50	UHF *Micor* Base and Repeater Station Manual
68P81025E60	*Micor* Base and Repeater Station Control and Application Manual
68P81033E10	UHF *Pulsar* IMTS Base Station Manual
68P81033E15	VHF *Pulsar* IMTS Base Station Manual
68P81034E25	UHF *DVP Micor* Base and Repeater Station Manual
68P81036E40	VHF *DVP Micor* Base and Repeater Station Manual
68P81039E55	UHF *Micor* Base and Repeator Station Manual

REVISION DETAILS

MODEL NO	DELETE	ADD
TCN1148A	TLN5649A	TRN9376A
TCN1223A	TLN5892A	TRN9377A
TCN1264A	TRN6935A	TRN9378A
TCN1280A	TRN8105A	TRN9379A
TCN1386A	TRN5437A	TRN9380A

The deleted kits and added kits are identical except that the chassis hardware kit, part number 1-80780D22 (quantity 2), is deleted in all models but TRN9380A where only one chassis hardware kit, part number 1-80780D22 (quantity 1), is deleted. The change was made to facilitate manufacturing and material distribution.

MOTOROLA INC.

instruction manual revision

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

68P81033E15-A PULSAR IMTS Base Stations
150.8-160 MHz, 40-100 Watts
DC and Tone Control Models

REVISION DETAILS:

REMOTE CHASSIS AND MODULES Tab

In section 68P81041E48-B, TLN5938A Line Driver Module, add parts list PL-6405-A.

ATTACHMENT:

TLN5938A Line Driver Board Parts List . . .PL-6405-A

SMR-4317
10/19/81

MOTOROLA INC.

instruction manual revision

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

68P81033E15-A	PULSAR IMTS Base Stations 150.8-160 MHz, 40-100 Watts DC and Tone Control Models

REVISION DETAILS:

REMOTE CHASSIS AND MODULES Tab

In section 68P81041E48-B, TLN5938A Line Driver Module, add parts list PL-6405-A.

ATTACHMENT:

TLN5938A Line Driver Board Parts List . . .PL-6405-A

SMR-4317
10/19/81

Instruction manual revision

MOTOROLA INC.

instruction manual revision

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUALS AFFECTED:

68P81033E10-A	PULSAR IMTS Base Stations, DC and Tone Control Models (450-512 MHz)
68P81033E15-A	PULSAR IMTS Base Stations, DC and Tone Control Models (150.8-160 MHz)

REVISION DETAILS:

Update your manual to show that TLN5940B Tone Function Decoder Module replaces the TLN5940A. The TLN5940B is the same as TLN5940A described in your manual except for the value of capacitor C204 which is given below.

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C204	21-82428B27	.0047 uF±10%; 100 V

parts list

TLN5938A Line Driver Board — PL-6405-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF ±10%; 50 V: unless otherwise stated
C1, 2	23-84538G01	1.0 ±20%; 35 V
C3	23-84538G04	15 ±20%; 20 V
C4	8-82905G11	.22
C5	21-82187B07	470 pF; 500 V
C6	8-82905G39	.023 ±5%
C7	21-82187B43	.0039; 200 V
C8	23-84538G01	1.0 ±20%; 35V
C9	8-82905G11	.22
C10	8-863305	2; 200 V
C11	8-82905G03	.047
C12	8-82905G01	.01
C13	23-84762H07	4.7 ±20%; 10 V
C14	8-82905G01	.01
C15	23-83210A19	500; 20 V
C16, 17, 18	23-84538G01	1.0 ±20%; 35 V
C19	8-82905G11	.22
C20	21-82428B27	.0047; 100 V
C21	23-83397D01	3.3 ±20%; 20 V
C22	21-82187B20	.001; 100 V
C23	8-82905G45	.082
C24, 25	23-84538G01	1.0 ±20%; 35 V
C26	23-84538G04	15 ±20%; 20 V
C27	21-82187B20	.001; 100 V
C28	23-84538G04	15 ±20%; 20 V
C29	8-82905G01	.01
C30	8-863305	2.0; 200 V
C31	21-82187B20	.001; 100 V
C32 thru 35	21-82372C01	0.1
C36	8-82905G09	.12; 50 V
C37	23-84538G01	1.0 ±; 35 V
C38	23-84538G04	15 ±20%; 20 V
		diode: (see note)
CR1, 2, 3	48-83654H01	silicon
		connector, receptacle:
J1 thru 7	9-83073L02	phono
J8		consists of 28-84269C01 CONNECTOR, male; 3 req'd. 28-84269C02 CONNECTOR, male; 2 req'd.
		coil, af:
L1	24-84003A01	6 H
L2	25-82113H02	1 H
L3	24-84003A01	6 H
		transistor: (see note)
Q1, 2	48-869642	NPN; type M9642
Q3	48-869539	NPN; type M9539
Q4, 5	48-869642	NPN; type M9642
Q6, 7	48-869643	PNP; type M9643
Q8 thru 11	48869642	NPN; type M9642
Q12, 13	48-869594	NPN; type M9594
Q14, 15	48-869642	NPN; type M9642
Q16, 17	48-869660	FET; type M9660
		resistor, fixed: ±5%; 1/4 W unless otherwise stated
R1	6-11009C99	120k
R2	6-11009D02	150k
R3	6-11009C89	47k
R4	6-11009C33	220
R6	6-11009D14	470k
R7	6-11009C65	4.7k
R8	6-11009C91	56k
R9	6-11009C33	220
R10	6-11009C73	10k
R11, 12	6-11009C43	560
R13	6-11009D04	180k
R14	6-11009D06	220k
R15	6-11009C85	33k
R16	6-11009C95	82k
R18	18-83518L01	var. 1k
R19	6-11009C85	33k
R20	6-11009C81	22k
R21	6-11009C77	15k
R22	6-11009C73	10k
R23	6-11009C85	33k
R24	6-11009C81	22k
R25	6-11009C77	15k
R26	6-11009C73	10k
R27	6-11009C83	27k
R28	6-11009D02	150k
R29, 30	6-11009C79	18k
R31, 32	6-11009C41	470
R33, 34	6-11009C57	2.2k
R35	6-11009C42	510
R36, 37	6-125A31	180; 1/2 W
R38	6-11009C51	1.2k
R39	6-11009C73	10k
R40	6-11009C87	39k
R41	6-11009C89	47k
R42, 43	6-11009C49	1k
R44	6-11009C91	56k
R45	6-11009C01	10
R46	6-11009C77	15k
R47	6-11009D22	1.0 meg
R48	6-11009C89	47k
R49	6-11009C71	8.2k
R50	6-11009C97	100k
R51	6-11009C73	10k
R52	6-11009C49	1k
R53	6-11009C25	100
R54	6-11009C55	1.8k
R55	6-11009C81	47k
R56	6-11009C53	1.5k
R57	6-11009C73	10k
R58	6-11009C65	4.7k
R59	6-11009C81	47k
R60	6-11009D22	1.0 meg
R61	18-83518L02	var. 25k
R62	6-11009C65	4.7k
R63	6-11009C95	82k
R64	6-11009C73	10k
R65	6-11009C65	4.7k
R66	6-11009C44	470
R67	6-11009C43	560
R68	6-11009C73	10k
R69	6-11009C55	1.8k
R70	6-11009C45	680
R71	6-11009C43	560
R72	6-11009D14	470k
R73	6-11009C13	33
R74	6-11009C65	4.7k
R75	6-11009C73	10k
R76	6-11009D14	470k
R77	6-11009C37	330
R79	6-11009C51	1.2k
R80	6-11009C65	4.7k
R81	6-11009D02	150k
R83	6-11009C65	4.7k
		switch, slide:
S1	40-83204B01	dpdt
		transformer, line driver:
T1, 2	25-83036L01	pins #7 and 9 dc resist. = 250 ohms pins #1 and 2 dc resist. = 25 ohms pins #3 and 4 dc resist. = 25 ohms pins #11 and 12 dc resist. = 250 ohms

non-referenced items

1-80796B17	CIRCUIT BOARD
	includes:
9-83011H01	RECEPTACLE, board mounting; 24 used
28-84269C01	CONNECTOR, male
28-84269C02	CONNECTOR, male
39-10184A10	CONTACT, plug; 8 used
43-865080	BUSHING, threaded; 2 used
1-80797B07	PANEL, riveted
	includes: ref. items S1
1-80799B80	JUMPER, assembly, 2 used
	includes:
29-83167C01	TERMINAL, strain relief
39-10184A24	CONTACT, receptacle
3-134184	SCREW, tapping; 4-40 x 5/16"; 2 used
3-134212	SCREW, tapping; 4-40 x 5/16"; 2 used
7-83164L01	BRACKET, panel
42-10217A02	STRAP, tie

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

MOTOROLA INC.

instruction manual revision

GENERAL

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

68P81033E15-A PULSAR IMTS Base Station, DC and Tone Control Models

REVISION DETAILS:

Under RECEIVER tab:

Replace MICOR SENSITRON High Band Receiver RF & I-F Board section 68P81036E37-K with attached section 68P81036E37-L.

ATTACHMENT:

MICOR SENSITRON High Band Receiver RF & I-F Board. 68P81026E37-L

"MICOR" "SENSITRON" HIGH BAND RECEIVER RF & IF BOARD

TLD8270B SERIES

MODEL TABLE

MODEL	FREQUENCY RANGE (MHz)
TLD8271B	132-142
TLD8272B	142-150.8
TLD8273B	150.8-162
TLD8274B	162-174

TECHNICAL CHARACTERISTICS

INPUT IMPEDANCE		50 ohms
RF FREQUENCY RANGE		132-174 MHz
CHANNEL ELEMENT FREQUENCY RANGE		15.455-18.055 MHz
CHANNEL SPACING		30 kHz
NUMBER OF CHANNELS		1 (capable of up to 4 for special applications)
SELECTIVITY EIA SINAD		-100 dB @±30 kHz
INTERMODULATION EIA SINAD		-80 dB
MODULATION ACCEPTANCE EIA		±7 kHz
SENSITIVITY (50 OHMS RF INPUT IMPEDANCE)	20 dB Quieting	less than 0.5 microvolt
	EIA Sinad	less than 0.35 microvolt
OSCILLATOR (CHANNEL ELEMENT) STABILITY		±.0005% (AFC optional) from -30°C to +60° C ambient
SPURIOUS & IMAGE REJECTION		-100 dB
POWER REQUIREMENTS		regulated 9.6 volts @ 70 mA 13.8 volts @ 20 mA
CONSTRUCTION		fully solid-state, two integrated circuits
RECEIVER TYPE		FM superheterodyne single conversion
IF FREQUENCY		11.7 MHz or 11.8 MHz
CRYSTAL FILTER TYPE		dual resonator, mode coupled, monolithic crystal
DISCRIMINATOR TYPE		dual resonator, mode coupled, monolithic crystal
METERING		three test points critical to operation and alignment are accessible at a metering receptacle which permits testing with a Motorola portable test set, optional built-in metering, or any 50 microampere meter.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

© Motorola, Inc.
Printed in U.S.A.

68P81026E37-L
7/26/UP

1. DESCRIPTION

1.1 The fully solid-state receivers rf & i-f circuit board which is used for both base station and "Spectra TAC" applications, consist of an rf preselector, two integrated circuits, three transistors, two i-f crystal filters, plug-in channel elements, and a crystal discriminator. These components are used to develop a low-noise audio siganl from a frequency modulated "on-channel" rf carrier in the 132-174 MHz range.

1.2 All circuits are constructed on a single plug-in circuit board which is easily removed and replaced. All external dc and audio connections are made at a single row of pins which eliminate interconnecting wires; rf input is provided by a single plug-in coaxial cable. Circuit board plating is on both sides of the board with all components mounted on the back side. All alignment points are accessible from the front of the station.

2. FUNCTIONAL OPERATION

This circuit board is a highly selective, crystal controlled, single conversion FM receiver (less audio amplifier, squelch circuitry, and speaker). Bandwidth and selectivity characteristics are determined by rf preselector coils and i-f crystal filters. Plug-in crystal oscillator modules (channel elements) provide stable frequency control. Integrated circuits are used for all amplification and limiting after the first crystal filter section which produce high i-f signal gain and exceptionally high reliability. A crystal discriminator is used to provide high audio recovery from the i-f signal. Refer to schematic diagram for more circuit details.

3. MAINTENANCE

3.1 GENERAL

This section of the manual provides the maintenance procedures for the receiver rf and i-f section of the receiver. These bench tests include metering measurements and procedures for testing and troubleshooting, including integrated circuit check-out.

NOTE

The receiver rf and i-f board must be installed in the receiver for testing to provide the necessary power, ground, control and signal connections. The board should always be secured in place with all mounting screws for operation and testing to provide a good rf ground to all stages of the receiver. The board may be installed in the station or a "Micor" mobile radio set for testing.

3.2 "SPECTRA TAC" 20 DB QUIETING SENSITIVITY TEST

This performance test may be used after repair and alignment to assure that the receiver meets all specifications before it is returned to service.

It may be performed using a Motorola S-1056B thru S-1059B Portable Test Set or optional built-in receiver metering. J101 can accommodate only the built-in metering set or the portable test set, but not both simultaneously. Plugging a portable test set in a receiver that has built-in metering will disconnect the built-in metering cable.

NOTE

The receiver shield must be in place while performing this test.

3.2.1 Using the Portable Test Set and an AC Voltmeter

Step 1. The receiver rf and i-f board must be installed in a complete receiver for testing. Make sure the rf and i-f circuit board mounting screws are all secure and that all connections to the board are properly made.

Step 2. Be sure the receiver shield is in place.

Step 3. Apply ac input power to the receiver.

Step 4. Using a TEK-37A Adapter Cable, connect a Motorola portable test set or meter panel to the station as follows:

--Connect the adapter cable 20-pin connector to the receptacle on the front of the test set or meter panel.

--Connect the adapter cable 7-pin white "metering" plug to the metering receptacle on the receiver rf and i-f board.

Step 5. Set the portable test set switches as follows:

--Set the function switch to the RCVR position.

--Set the meter reversing switch to the OFF position.

--Set the adapter cable SENS switch to the 100 mV position. If the adapter cable has no SENS switch, the unit operates at 100 mV all of the time.

--Set the adapter cable reference switch to position A or position B.

Step 6. Refer to the meter reading table in paragraph 3.3.1. Set the test set selector switch to the positions called for in the table and observe the test set meter. Notice that the meter readings given in the table are minimums.

Step 7. Connect an ac voltmeter across pins 1 and 18 of the audio control module.

Step 8. (PL receivers only). Disable PL, using the switch on the PL module.

Step 9. Set the receiver squelch control fully counterclockwise (unsquelched).

Step 10. Adjust the LINE LEVEL control so the ac voltmeter reads 565 mV volts ac.

Step 11. Set the signal generator controls as follows:

--Set up the signal generator to produce a CW or unmodulated signal.

--Set the generator output level to maximum.

--Set the signal generator output frequency to the selected channel receive frequency. To set the signal generator on frequency without a frequency counter, adjust the generator frequency control until test set meter position 4 reads exactly zero.

Step 12. Slowly decrease the signal generator output level until the ac voltmeter reads 565 mV ac (20 dB down from 565 mV ac). Switch to a lower voltmeter scale if necessary. The generator output now indicates the 20 dB quieting sensitivity and should be 0.5 microvolt, or less (0.25 microvolt with preamplifier).

Step 13. Readjust the LINE LEVEL control as described in the MAINTENANCE section of the manual.

3.2.2 Using the Optional Built-In Receiver Metering

3.2.2.1 Unsquelch the receiver by turning the SQUELCH control fully counterclockwise. "Private-Line" receivers must also be PL disabled. Turn metering POWER switch on.

3.2.2.2 Set the meter selector switch to position 6 and the speaker switch to the OFF position. Adjust the receiver LINE LEVEL control for 50 uA as indicated on the meter.

3.2.2.3 Connect a signal generator to the station antenna receptacle and adjust it to the receiver frequency. Set the rf output to minimum.

3.2.2.4 Increase the signal generator output until the meter reading drops to 5 uA. The generator output level now indicates the 20 dB quieting sensitivity and should be 0.5 microvolt, or less (0.25 microvolt, or less, with preamplifier). Readjust the line level as described in the MAINTENANCE section in the front of the manual.

3.3 "SPECTRA TAC" TROUBLESHOOTING

3.3.1 Circuit Measurements

3.3.1.1 General

A failure in almost any part of the rf and i-f section will produce an improper meter reading on one or more of the test points. Improper alignment will also cause improper meter readings.

A "0" meter reading in position 3 or 5 indicates either (1) insufficient drive from a preceding stage or (2) a defective component at the metering point.

3.3.1.2 Procedure Using Portable Test Set or Optional Built-In Receiver Metering

3.3.1.2.1 (Portable test set only). Connect the 20-pin plug of the adapter cable to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve test set battery life. The plug acts as an on-off switch completing the battery circuit.

3.3.1.2.2 (Portable test set only). Connect the white "metering" plug of the adapter cable to the metering receptacle on the receiver rf and i-f circuit board.

3.3.1.2.3 Compare the current readings in SELECTOR SWITCH positions 3, 4 and 5 with those in the following table. A low reading on meter position 3 indicates a defective channel element or multiplier circuit. An improper meter reading in position 4 or 5 readings indicate a malfunction elsewhere in the receiver, which can most rapidly be found by checking rf and i-f voltages, per the schematic diagram.

TYPICAL RECEIVER RF & IF METER READINGS TABLE
(No Input Signal Applied)

SELECTOR SWITCH POSITION	READING (MICROAMPS)	CIRCUIT METERED
3	15	Channel Element Output
4	0 ±2	Discriminator Output
5	1 or less (If unreadable, inject 1.0 V on-channel signal at antenna receptacle; 20 uA, typical, should be obtained.)	3rd i-f Amplifier and Limiter

3.3.2 Input Voltages

If there are no test set indications at one or more of the metered points, check the dc input voltages to the receiver rf and i-f circuit board.

P904-9	A+ (13.8 V dc with reference to chassis)
P904-6 P904-13	9.6 V dc (with reference to chassis) (±0.5 V)

If test set indications localize the trouble to a specific stage or two, measure the dc input voltages to the suspected stages. Refer to the schematic diagram for the normal voltages.

3.3.3 Alignment as a Troubleshooting Technique

Low test set readings, improper discriminator output, and otherwise abnormal performance are very often corrected by re-alignment. Therefore, alignment should be the first troubleshooting step performed for these symptoms. Many technicians prefer to use alignment as the first troubleshooting step in all cases.

3.3.4 Isolating Defective Components

If test set readings are abnormal or tests indicate sub-normal performance, a logical troubleshooting procedure is required to isolate the defective component. The accompanying troubleshooting chart summarizes troubleshooting in a logical sequence. A few voltage and resistance checks in the suspected circuit should readily isolate the defective component.

3.3.5 Troubleshooting Integrated Circuits

The IC's in the receiver rf and i-f section may be checked by dc voltage measurements. Proper voltages are shown on the schematic diagram.

3.3.6 Troubleshooting Crystals

A defective filter crystal can best be found by performing an i-f gain check per the schematic diagram. A defective crystal will show an abnormally high insertion loss. Before making the gain check, verify, using an ohmmeter, that the center pins of all four filter crystals are connected to the associated crystal case. The resistance between the center pin and the case should be less than 0.1 ohm. The loss of this ground may cause errors in gain measurements because of the loss of shielding effectiveness. If the filter is found to be defective because of high insertion loss or an ungrounded case, it should be replaced.

Before replacing the discriminator crystal, verify that all components associated with the discriminator circuitry are not defective. Also, verify, in a manner similar to that used for the filter crystals, that pin 2 is connected (less than 0.1 ohm) to the crystal case. The discriminator crystal should be replaced if found defective.

NOTE

If the discriminator crystal, Y105, is replaced, it must be physically oriented so that the index dot on the top of the filter can is toward IC102 on the circuit board. This crystal matches specific input and output impedance and will not perform satisfactorily if reversed. All other filter crystals, if replaced, may be oriented in either direction.

3.4 20 DB QUIETING SENSITIVITY TEST (BASE STATION)

This performance test may be used after repair and alignment to assure that the receiver meets all specifications before it is returned to service.

It may be performed using a Motorola S-1056B thru S-1059B Portable Test Set or optional built-in station metering.

NOTE

The receiver shield must be in place while performing this test.

3.4.1 Using the Portable Test Set

3.4.1.1 Unsquelch the receiver by turning the SQUELCH control fully counter-clockwise. "Private-Line" stations must also be PL disabled.

3.4.1.2 Connect the red "control" plug of the adapter cable to the control receptacle on the local or remote control board. This is the large board in the applicable local or remote control package.

3.4.1.3 Set the multiplier switch on the test set to the 2 V AC position.

3.4.1.4 Adjust the VOLUME control until 2 volts is obtained on meter position 11. Set the speaker switch of the test set to the LOAD position to silence the test set speaker during the test.

3.4.1.5 Connect the signal generator to the station antenna receptacle and adjust it to the receiver frequency. Set the rf output to minimum.

3.4.1.6 Increase the signal generator output until the meter reading drops to .2 volts in meter position 11 (place the multiplier switch in the .2 V AC position). The generator output level now indicates the 20 dB quieting sensitivity and should be 0.5 microvolt, or less (0.25 microvolt with preamplifier).

3.4.2 Using the Optional Built-In Station Metering

3.4.2.1 Unsquelch the receiver by turning the SQUELCH control fully counter-clockwise. "Private-Line" stations must also be PL disabled.

3.4.2.2 Set the range switch on an ac voltmeter to the 2 V AC position and connect the voltmeter across the speaker terminals of the built-in station meter kit. Adjust the station VOLUME control for 2 volts as indicated on the voltmeter.

3.4.2.3 Connect a signal generator to the station antenna receptacle and adjust it to the receiver frequency. Set the rf output to minimum.

3.4.2.4 Increase the signal generator output until the meter reading drops to .2 volts. The generator output level now indicates the 20 dB quieting sensitivity and should be 0.5 microvolt, or less (0.25 microvolt, or less, with preamplifier).

3.5 TROUBLESHOOTING (BASE STATION)

3.5.1 Circuit Measurements

3.5.1.1 General

A failure in almost any part of the rf and i-f section will produce an improper meter reading on one or more of the test points. Improper alignment will also cause improper meter readings.

A "0" meter reading in position 3 or 5 indicates either (1) insufficient drive from a preceding stage or (2) a defective component at the metering point.

3.5.1.2 Procedure Using Portable Test Set or Optional Built-In Station Metering

3.5.1.2.1 (Portable test set only). Connect the 20-pin plug of the adapter cable to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve test set battery life. The plug acts as an on-off switch completing the battery circuit.

3.5.1.2.2 (Portable test set only). Connect the red "control" plug of the adapter to the receptacle on the local or remote control board. Connect the white "metering" plug of the adapter cable to the metering receptacle on the receiver rf and i-f circuit board.

3.5.1.2.3 Compare the current readings in SELECTOR SWITCH positions 3, 4 and 5 with those in the following table. A low reading on meter position 3 indicates a defective channel element or multiplier circuit. An improper meter reading in position 4 or 5 readings indicate a mal-

function elsewhere in the receiver, which can most rapidly be found by checking rf and i-f voltages, per the schematic diagram.

TYPICAL RECEIVER RF & I-F METER READINGS TABLE
(No Input Signal Applied)

Selector Switch Position	Reading (Microamps)	Circuit Metered
3	15	Channel Element Output
4	0 ±2	Discriminator Output
5	1 or less (If unreadable, inject 1.0 V on-channel signal at antenna receptacle; 20 uA, typical, should be obtained.)	

3.5.2 Input Voltages

If there are no test set indications at one or more of the metered points, check the dc input voltages to the receiver rf and i-f circuit board. Key and unkey the transmitter to see if the voltages are switched.

P904-9	A + (13.8 V dc with reference to chassis)
P904-6	
P904-13	9.6 V dc (with reference to chassis) (±0.5 V)

If thest set indications localize the trouble to a specific stage or two, measure the dc input voltages to the suspected stages. Refer to the schematic diagram for the normal voltages.

NOTE

In "Private-Line" radios, the transmitter cannot be keyed if the PL encoder board is removed unless a jumper is connected from pin 8 to pin 10 of the exciter to complete the keying circuit. This jumper is permanently connected in exciters for non-"Private-Line" operation.

3.5.3 Alignment as a Troubleshooting Technique

Low test set readings, improper discriminator output, and otherwise abnormal performance are very often corrected by re-alignment. Therefore, alignment should be the first troubleshooting step performed for these symptoms. Many technicians perfer to use alignment as the first troubleshooting step in all cases.

3.5.4 Isolating Defective Components

If test set readings are abnormal or tests indicate sub-normal performance, a logic troubleshooting procedure is required to isolate the defective component. The accompanying troubleshooting chart summarizes troubleshooting in a logical sequence. A few voltage and resistance checks in the suspected circuit should readily isolate the defective component.

3.5.5 Troubleshooting Integrated Circuits

Integrated circuits (IC's) are very reliable components and should not be replaced until all checks have proven definitely that the IC is the defective component. Removal of an IC is time consuming and often ruins the part. Therefore, a few extra checks before that task is attempted are worthwhile. Before replacing a bad IC, make sure that the external components in the circuit are normal.

The IC's in the receiver rf and i-f section may be checked by dc voltage measurements. Proper voltages are shown on the schematic diagram.

3.5.6 Troubleshooting Crystals

A defective filter crystal can best be found by performing an i-f gain check per the schematic diagram. A defective crystal will show an abnormally high insertion loss. Before making the gain check, verify, using an ohmmeter, that the center pins of all four filter crystals are connected to the associated crystal case. The resistance between the center pin and the case should be less than 0.1 ohm. The loss of this ground may cause errors in gain measurements because of the loss of shielding effectiveness. If the filter is found to be defective because of high insertion loss or an ungrounded case, it should be replaced.

Before replacing the discriminator crystal, verify that all components associated with the discriminator circuitry are not defective. Also, verify, in a manner similar to that used for the filter crystals, that pin 2 is connected (less than 0.1 ohm) to the crystal case. The discriminator crystal should be replaced if found defective.

3.4 20 DB QUIETING SENSITIVITY TEST (BASE STATION)

This performance test may be used after repair and alignment to assure that the receiver meets all specifications before it is returned to service.

It may be performed using a Motorola S-1056B thru S-1059B Portable Test Set or optional built-in station metering.

NOTE

The receiver shield must be in place while performing this test.

3.4.1 Using the Portable Test Set

3.4.1.1 Unsquelch the receiver by turning the SQUELCH control fully counter-clockwise. "Private-Line" stations must also be PL disabled.

3.4.1.2 Connect the red "control" plug of the adapter cable to the control receptacle on the local or remote control board. This is the large board in the applicable local or remote control package.

3.4.1.3 Set the multiplier switch on the test set to the 2 V AC position.

3.4.1.4 Adjust the VOLUME control until 2 volts is obtained on meter position 11. Set the speaker switch of the test set to the LOAD position to silence the test set speaker during the test.

3.4.1.5 Connect the signal generator to the station antenna receptacle and adjust it to the receiver frequency. Set the rf output to minimum.

3.4.1.6 Increase the signal generator output until the meter reading drops to .2 volts in meter position 11 (place the multiplier switch in the .2 V AC position). The generator output level now indicates the 20 dB quieting sensitivity and should be 0.5 microvolt, or less (0.25 microvolt with preamplifier).

3.4.2 Using the Optional Built-In Station Metering

3.4.2.1 Unsquelch the receiver by turning the SQUELCH control fully counter-clockwise. "Private-Line" stations must also be PL disabled.

3.4.2.2 Set the range switch on an ac voltmeter to the 2 V AC position and connect the voltmeter across the speaker terminals of the built-in station meter kit. Adjust the station VOLUME control for 2 volts as indicated on the voltmeter.

3.4.2.3 Connect a signal generator to the station antenna receptacle and adjust it to the receiver frequency. Set the rf output to minimum.

3.4.2.4 Increase the signal generator output until the meter reading drops to .2 volts. The generator output level now indicates the 20 dB quieting sensitivity and should be 0.5 microvolt, or less (0.25 microvolt, or less, with preamplifier).

3.5 TROUBLESHOOTING (BASE STATION)

3.5.1 Circuit Measurements

3.5.1.1 General

A failure in almost any part of the rf and i-f section will produce an improper meter reading on one or more of the test points. Improper alignment will also cause improper meter readings.

A "0" meter reading in position 3 or 5 indicates either (1) insufficient drive from a preceding stage or (2) a defective component at the metering point.

3.5.1.2 Procedure Using Portable Test Set or Optional Built-In Station Metering

3.5.1.2.1 (Portable test set only). Connect the 20-pin plug of the adapter cable to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve test set battery life. The plug acts as an on-off switch completing the battery circuit.

3.5.1.2.2 (Portable test set only). Connect the red "control" plug of the adapter to the receptacle on the local or remote control board. Connect the white "metering" plug of the adapter cable to the metering receptacle on the receiver rf and i-f circuit board.

3.5.1.2.3 Compare the current readings in SELECTOR SWITCH positions 3, 4 and 5 with those in the following table. A low reading on meter position 3 indicates a defective channel element or multiplier circuit. An improper meter reading in position 4 or 5 readings indicate a mal-

function elsewhere in the receiver, which can most rapidly be found by checking rf and i-f voltages, per the schematic diagram.

TYPICAL RECEIVER RF & I-F METER READINGS TABLE
(No Input Signal Applied)

Selector Switch Position	Reading (Microamps)	Circuit Metered
3	15	Channel Element Output
4	0 ±2	Discriminator Output
5	1 or less (If unreadable, inject 1.0 V on-channel signal at antenna receptacle; 20 uA, typical, should be obtained.)	

3.5.2 Input Voltages

If there are no test set indications at one or more of the metered points, check the dc input voltages to the receiver rf and i-f circuit board. Key and unkey the transmitter to see if the voltages are switched.

P904-9	A + (13.8 V dc with reference to chassis)
P904-6	
P904-13	9.6 V dc (with reference to chassis) (±0.5 V)

If thest set indications localize the trouble to a specific stage or two, measure the dc input voltages to the suspected stages. Refer to the schematic diagram for the normal voltages.

NOTE

In "Private-Line" radios, the transmitter cannot be keyed if the PL encoder board is removed unless a jumper is connected from pin 8 to pin 10 of the exciter to complete the keying circuit. This jumper is permanently connected in exciters for non-"Private-Line" operation.

3.5.3 Alignment as a Troubleshooting Technique

Low test set readings, improper discriminator output, and otherwise abnormal performance are very often corrected by re-alignment. Therefore, alignment should be the first troubleshooting step performed for these symptoms. Many technicians perfer to use alignment as the first troubleshooting step in all cases.

3.5.4 Isolating Defective Components

If test set readings are abnormal or tests indicate sub-normal performance, a logic troubleshooting procedure is required to isolate the defective component. The accompanying troubleshooting chart summarizes troubleshooting in a logical sequence. A few voltage and resistance checks in the suspected circuit should readily isolate the defective component.

3.5.5 Troubleshooting Integrated Circuits

Integrated circuits (IC's) are very reliable components and should not be replaced until all checks have proven definitely that the IC is the defective component. Removal of an IC is time consuming and often ruins the part. Therefore, a few extra checks before that task is attempted are worthwhile. Before replacing a bad IC, make sure that the external components in the circuit are normal.

The IC's in the receiver rf and i-f section may be checked by dc voltage measurements. Proper voltages are shown on the schematic diagram.

3.5.6 Troubleshooting Crystals

A defective filter crystal can best be found by performing an i-f gain check per the schematic diagram. A defective crystal will show an abnormally high insertion loss. Before making the gain check, verify, using an ohmmeter, that the center pins of all four filter crystals are connected to the associated crystal case. The resistance between the center pin and the case should be less than 0.1 ohm. The loss of this ground may cause errors in gain measurements because of the loss of shielding effectiveness. If the filter is found to be defective because of high insertion loss or an ungrounded case, it should be replaced.

Before replacing the discriminator crystal, verify that all components associated with the discriminator circuitry are not defective. Also, verify, in a manner similar to that used for the filter crystals, that pin 2 is connected (less than 0.1 ohm) to the crystal case. The discriminator crystal should be replaced if found defective.

NOTE

If the discriminator crystal, Y105, is replaced, it must be physically oriented so that the index dot on the top of the filter can is toward IC102 on the circuit board. This crystal matches specific input and output impedances and will not perform satisfactorily if reversed. All other filter crystals, if replaced, may be oriented in either direction.

3.5.7 Troubleshooting in the Optional AFC Amplifier

If the AFC amplifier is suspected to be malfunctioning, perform the following test:

3.5.7.1 If an optional built-in station meter is used, switch to position 4 to monitor the discriminator output. Otherwise, connect the Motorola test set to monitor the discriminator output (position 4).

3.5.7.2 Insert a shorting tool into the AFC DISABLE (short contact on board to receiver shield) and adjust the input signal or the receiver channel element warping capacitor for a test set meter indication of approximately 5 uA off zero center scale.

3.5.7.3 Remove the shorting tool to activate the AFC amplifier. The test set meter indication should return to within 2 uA of zero center scale.

3.6 TWO-RECEIVER STATIONS

The two-receiver coupler used to connect both receivers to an antenna does not require alignment. Align both receivers while disconnected from the two-receiver coupler. Inject siganl generator output into each receiver at the rf preselector (or preamp) and align. Then re-connect the two-receiver coupler and check for proper operation.

3.7 FIELD CONVERSION TO SHIFTED I-F

A standard 11.7 MHz i-f receiver can easily be converted to operate at the shifted i-f of 11.8 MHz. Replace crystal filters Y101 through Y105 with the 11.8 MHz parts; refer to the parts list for the TLD8740A Shifted I-F Crystal Kit for the part numbers. Finally, replace the channel element, using the 11.8 MHz i-f formula for calculating the crystal frequency.

RECEIVER AL

ER ALIGNMENT (Cont'd)

A. FREQ

Where:

f_o = channel e

f_c = carrier f

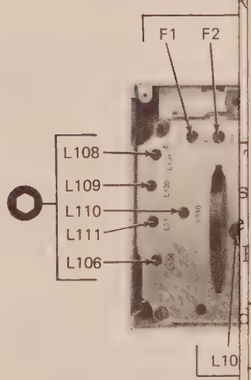
11.7 MHz IF F

$$f_o = \frac{f_c + 11.}{9}$$

$$f_o = \frac{f_c - 11.}{9}$$

. & R REV. TCH	STAGE AND PROCEDURE
R REV.	Adjust signal generator output for 25 uA meter indication. Detune L108 until meter indication decreases to 15 uA. Repeak L110 and L111 for maximum meter indication. Repeat entire step.
R REV.	Repeak L108 and L109 for maximum meter indication.
R REV.	Repeak L101 through L105 for maximum meter indication. Repeat. Peak L103 thru L105 for minimum indication on meter 6 (maximum quieting).
R REV.	ON-FREQUENCY ADJUSTMENT - Disconnect signal generator and transmit carrier signal from transmitter normally received. If transmitter is known to be on frequency, test set meter position 5 should indicate rise when transmitter is keyed (if necessary connect antenna). Check test set position 4 reading with transmitter keyed. 0 indicates on-frequency condition. Adjust F1 warp capacitor for exact 0 reading. DO NOT READJUST L108 OR L109 AFTER THESE ADJUSTMENTS ARE MADE. If the receiver is equipped with AFC, short the AFC DISABLE contact while adjusting F1.
	Perform 20 dB quieting sensitivity measurement as check of alignment.

B. RECEIVER



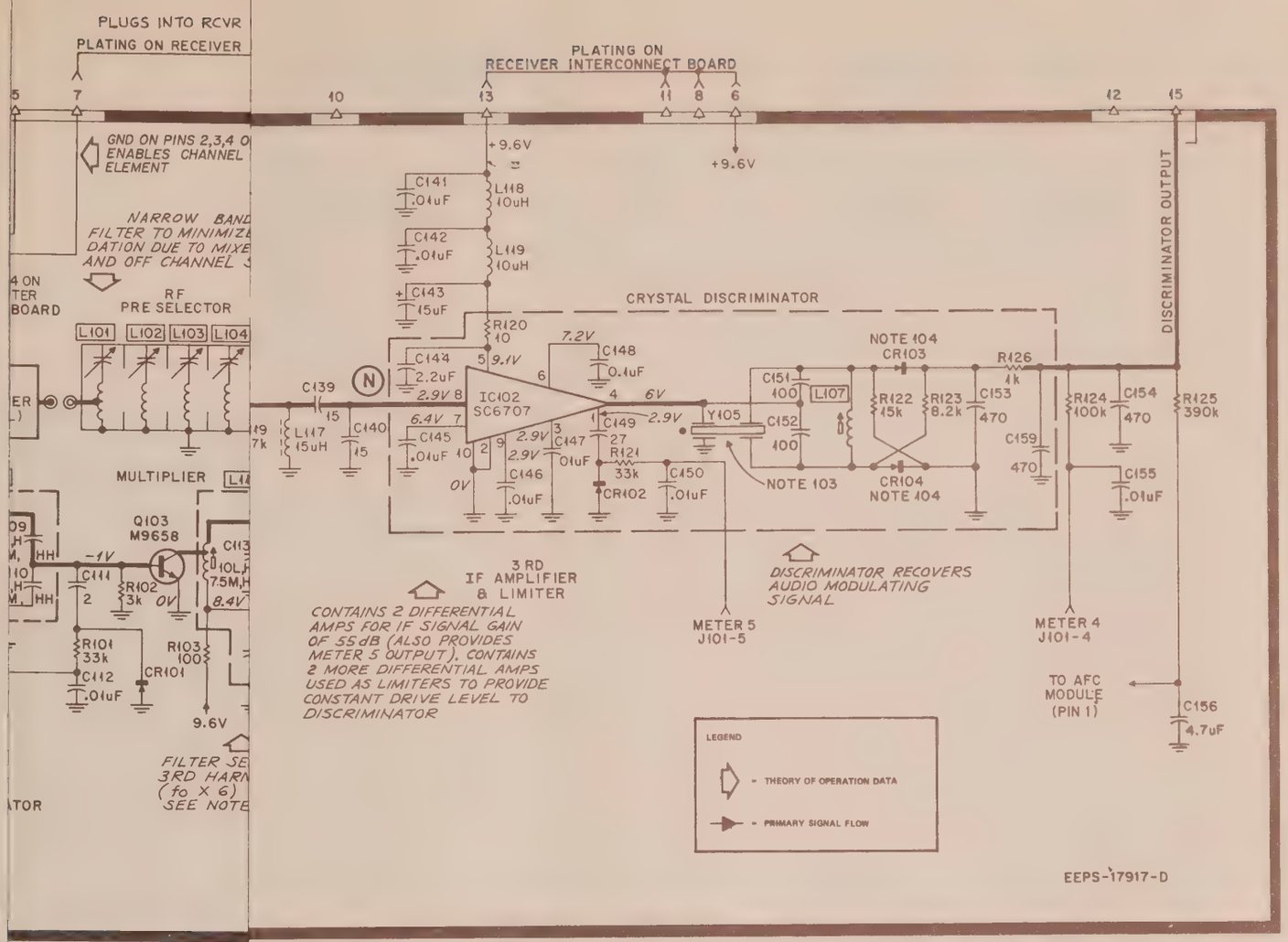
FAEPS-24812-A
(P413)

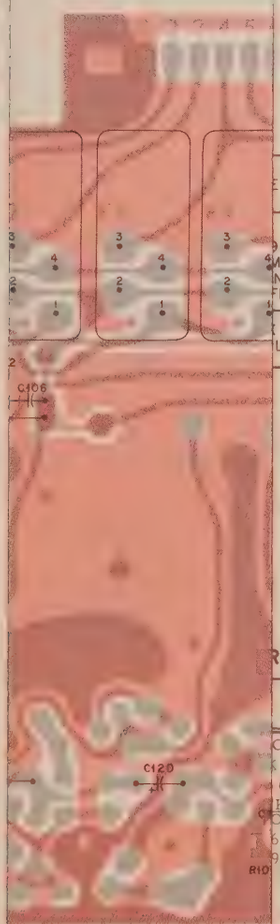
test set is used, connect an
across pins 1 and 18 of the
module for this reading.

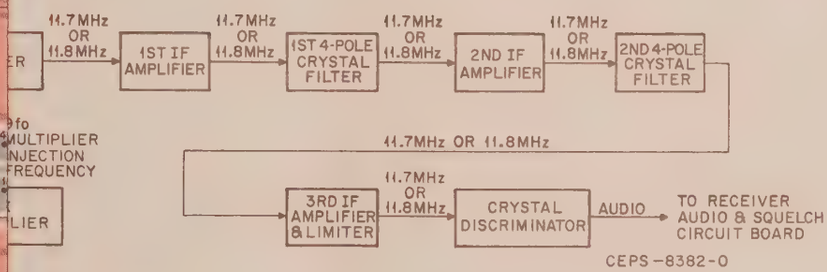
C. TYPICAL

(NO INE

TEST SET SELECTOR SWITCH POSITION	
3	
4	
5	1 or less maximum antenna r cal, shou







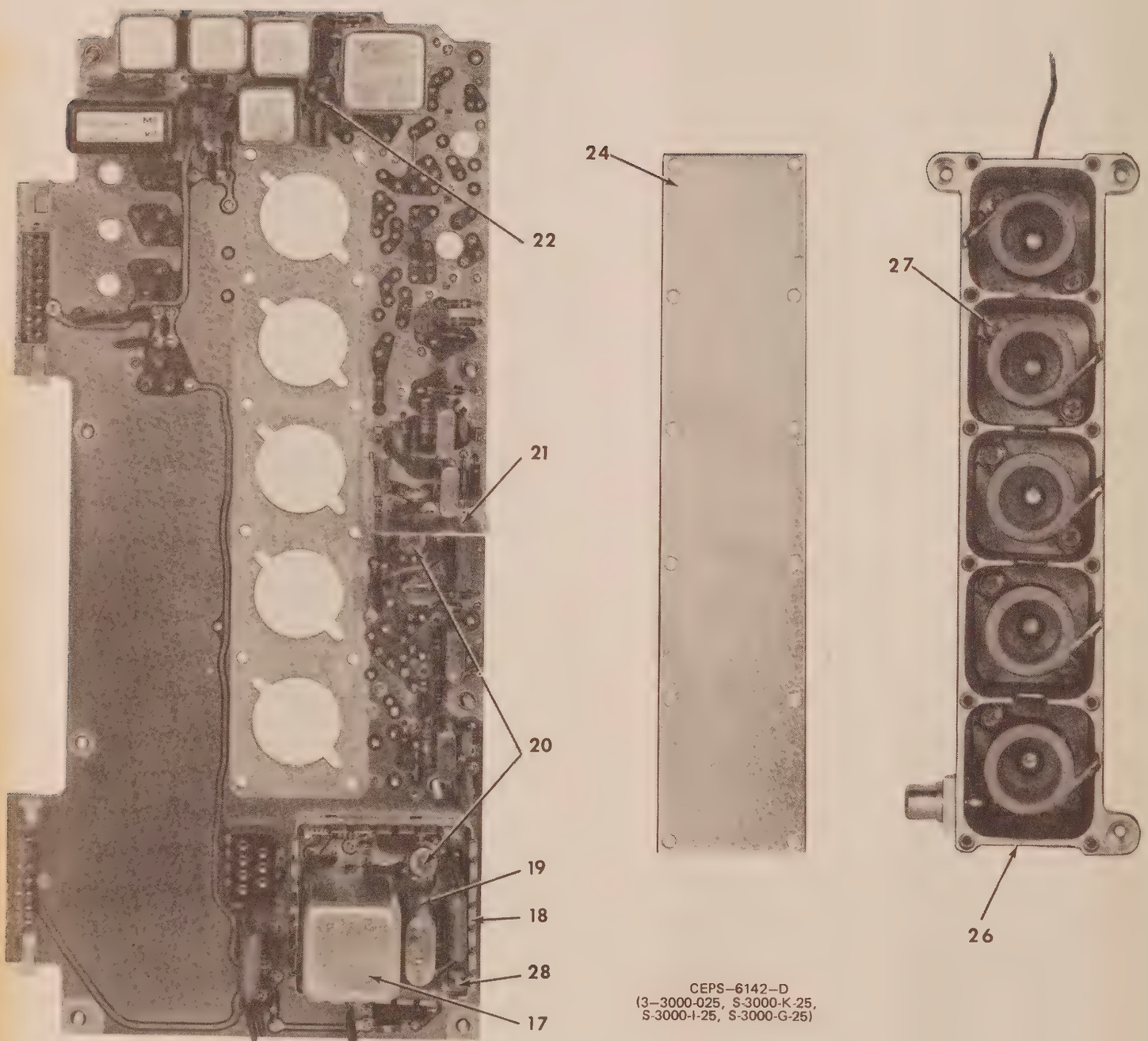
REVISIONS PEPS-17915-D

CHANGE	LOCATION
OM 6-129887 K ±5%; 1/4 W 6-124A65 K ±5%; 1/4 W	IC102, PIN 8
OM 48R869651, 651 TO 48-869943, 943	MIXER

PARTS LIST SHOWN ON
BACK OF THIS DIAGRAM

Receiver RF & I-F Board
Schematic Diagram, Circuit Board Detail
and Block Diagram
Motorola No. PEPS-17915-E
7/15/81- UP

HIGH BAND RECEIVER RF & IF BOARD



CEPS–6142–D
(3–3000-025, S-3000-K-25,
S-3000-I-25, S-3000-G-25)

MOTOROLA INC.
Communications
Group

VHF PULSAR™
IMTS BASE STATIONS
DC AND TONE CONTROL MODELS

CONTENTS

SECTION *NUMBER*

Foreword iv
Performance Specifications vi
Model Chart viii
Model Breakdown Chart ix
Factory Installed Options x

STATION DATA

DESCRIPTION 68P81041E74
Introduction . . . . . Page 1
Mechanical and Servicing Features . . . . . Page 1
Application . . . . . Page 1
Description of Items . . . . . Page 2
Functional Description . . . . . Page 5
Functional Diagram . . . . . Page 11

INSTALLATION 68P81042E41
Inspection . . . . . Page 1
Planning the Installation . . . . . Page 1
Ventilation . . . . . Page 1
Installation of Cabinet . . . . . Page 2
Connections . . . . . Page 2
Level Setting . . . . . Page 4
Station Cabinet Details . . . . . Page 9

SYSTEM AUDIO LEVEL ADJUSTMENTS 68P81060E24
Description . . . . . Page 2
Glossary of Abbreviations . . . . . Page 2
Receiver Levels (Micor Tone and DC Control Base Stations) . . . . . Page 2
Micor Tone Control Base Station Transmit Line Level Adjustments . . . . . Page 3
Receive Line Level Adjustments . . . . . Page 4
Motrac DC Controlled Base Station Line Level Adjustments . . . . . Page 5

STATION MAINTENANCE 68P81042E51
Introduction . . . . . Page 1
Local Operation for Testing & Maintenance . . . . . Page 1
Maintenance Techniques . . . . . Page 2
Routine Maintenance Check List . . . . . Page 3
Table of Recommended Test Equipment . . . . . Page 3

© Motorola, Inc. 1981
All Rights Reserved
Printed in U.S.A.

technical writing services
1301 E. Algonquin Road, Schaumburg, Il. 60196

68P81033E15-A
7/15/81-PHI

SECTION *NUMBER*

TRANSMITTER

TRANSMITTER INTRODUCTION 68P81042E88

TRANSMITTER INTERCONNECT BOARD 68P81041E44

EXCITER 68P81026E66
- Description ..... Page 1
- Functional Operation ..... Page 2
- Maintenance ..... Page 3
- Alignment Procedure ..... Page 7
- Schematic Diagram, Component Layout & Parts List ..... Page 9

90/100/110 W POWER AMPLIFIER 68P81039E38
- Description ..... Page 1
- Functional Operation ..... Page 2
- Maintenance ..... Page 2
- Troubleshooting ..... Page 5
- PA Repair Notes ..... Page 5
- Power Amplifier Alignment Procedure ..... Page 8
- Schematic Diagram, Component Layout & Parts List ..... Page 11

POWER CONTROL BOARD 68P81015E07
- Description ..... Page 1
- Functional Description ..... Page 2
- Circuit Description ..... Page 3
- Maintenance ..... Page 7
- Alignment Procedure ..... Page 11
- Schematic Diagram, Component Layout & Parts List ..... Page 13

RECEIVER

RECEIVER INTRODUCTION 68P81042E89

RECEIVER INTERCONNECT BOARD 68P81034E07

TLD8270B SERIES RECEIVER RF & I-F BOARD 68P81026E37
- Receiver Alignment Procedure ..... Page 1
- Description ..... Page 2
- Functional Operation ..... Page 2
- Maintenance ..... Page 2
- Schematic Diagram, Component Layout, & Parts List ..... Page 3

TRN6006A, TRN6007AV RECEIVER AUDIO AND SQUELCH BOARD 68P81025E79
- Description ..... Page 1
- Functional Operation ..... Page 1
- Maintenance ..... Page 4
- Schematic Diagram, Component Layout, & Parts List ..... Page 9

TLN4290B AUDIO POWER AMPLIFIER 68P81014E97
- Description ..... Page 1
- Servicing ..... Page 1
- Schematic Diagram, Component Layout, & Parts List ..... Page 3

POWER SUPPLIES

TPN1110A, TPN1110B POWER SUPPLY 68P81020E44

TPN1165A POWER SUPPLY 68P81041E49

SECTION *NUMBER*

MISCELLANEOUS

STATION HARDWARE AND INTERCABLING 68P81042E54

TLE8911A, TLD5571A RF WATTMETER 68P81041E76

TLN1956A, TLN1957A F-0 KIT 68P81042E12

TRN8222A POWER COUPLER 68P81042E11

T1480 SERIES FILTERS AND DUPLEXERS 68P81102E85

REMOTE CONTROL CHASSIS AND MODULES

REMOTE CONTROL CHASSIS 68P81041E51

TLN5938A LINE DRIVER MODULE 68P81041E48

TLN5939A STATION CONTROL MODULE 68P81041E39

TLN1946A PILOT TONE DECODER MODULE 68P81041E41

TLN5940A TONE FUNCTION DECODER MODULE 68P81041E42

TRN6085B ENCODER MODULE 68P81036E36

TLN5943A DC FUNCTION DECODER MODULE 68P81041E43

TLN5944A RECEIVER QUALITY SIGNAL (RQS) DETECTOR 68P81041E18

TLN5946A RECEIVER QUALITY SIGNAL (RQS) LINE CURRENT GENERATOR 68P81041E17

TLN1873A METERING MODULE 68P81041E38

TLN5948A SUB-AUDIBLE PAGING MODULE 68P81044E56

, Motorola, Pulsar, Micor, Motrac, Sensitron, Spectra-TAC, Vibrasender, and Vibrasponder are registered trademarks of Motorola, Inc.

FOREWORD

1. SCOPE OF MANUAL

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by Instruction Manual Revisions (SMR). These SMR's are added to the manuals as the engineering changes are incorporated into the equipment.

2. MODEL AND KIT IDENTIFICATION

Motorola equipments are specifically identified by an overall model number on the nameplate. In most cases, assemblies and kits which make up the equipment also have kit model numbers stamped on them. When a production or engineering change is incorporated, the applicable schematic diagrams are updated.

As diagrams are updated, information about the change is incorporated into a revision column. This revision column appears in the manual next to the parts list or, in some cases, on the diagram. It lists the reference number, part number, and description of the parts removed or replaced.

3. SERVICE

Motorola's National Service Organization offers one of the finest nation-wide installation and maintenance programs available to communication equipment users. This organization includes approximately 900 authorized Motorola Service Stations (MSS) located throughout the United States, each manned by one or more trained, FCC licensed technicians.

These MSS's are independently owned and operated and were selected by Motorola to service its customers. Motorola maintenance is available on either a time and material basis or on a periodic fixed-fee type arrangement.

The administrative staff of this organization consists of national, area and district service managers and district representatives, all of whom are Motorola employees with the objective to improve the service to our customers.

Should you wish to purchase a service contract for your Motorola equipment, contact your Motorola Service Representative, or write to:

National Service Manager
Motorola Communications and Electronics, Inc.
1303 E. Algonquin Road
Schaumburg, Illinois 60196

4. REPLACEMENT PARTS ORDERING

Motorola maintains a number of parts offices strategically-located throughout the United States. These facilities are staffed to process parts orders, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Communications Group products.

Orders for all parts *except* crystals, active filters, code plugs, channel elements, and "Vibrasender" ® and "Vibrasponder" ® resonant reeds should be sent to the nearest area parts center. Orders for instruction manuals should also be sent to the area parts center.

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Orders for crystals, channel elements, active filters, PROMs, code plugs, and reeds should be sent directly to the factory address listed on the following page. Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the chassis model number in which the part is used.

Orders for active filters, PROMs, code plugs, *Vibrasender* and *Vibrasponder* resonant reeds should specify type number and frequency, should identify the owner/operator of the communications system in which these items are to be used; and should include any serial numbers stamped on the components being replaced.

5. ADDRESSES

5.1 GENERAL OFFICES

MOTOROLA Communications and Electronics Inc.
Communications Group Parts Dept.
1313 E. Algonquin Rd.,
Schaumburg, Illinois 60196
Phone: 312-576-3900

5.2 U.S. ORDERS

WESTERN AREA PARTS
1170 Chess Drive, Foster City,
San Mateo, California 94404
Phone: 415-349-3111
TWX: 910-375-3877

MIDWEST AREA PARTS
1313 E. Algonquin Road
Schaumburg, Ill. 60196
Phone: 312-576-7322
TWX: 910-693-0869

MID-ATLANTIC AREA PARTS
7230 Parkway Drive
Hanover, Maryland 20176
Phone: 301-796-8600
TWX: 710-862-1941

EAST CENTRAL AREA PARTS
12995 Snow Road,
Parma, Ohio 44130
Phone: 216-267-2210
TWX: 810-421-8845

EASTERN AREA PARTS
85 Harristown Road,
Glen Rock, New Jersey 07452
Phone: 201-447-4000
TWX: 710-988-5602

PACIFIC SOUTHWESTERN AREA PARTS
P.O. Box 85036
San Diego, California 92138
Phone: 714-578-2222
TWX: 910-335-1634

GULF STATES AREA PARTS
8550 Katy Freeway
Suite 128
Houston, Texas 77024
Phone: 713-932-8955

SOUTHWESTERN AREA PARTS
P.O. Box 34290
3320 Belt Line Road,
Dallas, Texas 75234
Phone: 214-241-2151
TWX: 910-860-5505

SOUTHEASTERN AREA PARTS
P.O. Box 368
Decatur, Georgia 30031
Phone: 504-981-9800
TWX: 810-766-0876

5.3 CANADIAN ORDERS

MOTOROLA LTD.
National Parts Department
3125 Steeles Avenue East
Willowdale, Ontario M2H 2H6
Phone: 416-499-1441
TWX: 610-492-2713
Telex: 065-25191

5.4 ALL COUNTRIES EXCEPT U.S. AND CANADA

MOTOROLA, INC. OR MOTOROLA AMERICAS, INC.
International Parts Dept.
1313 E. Algonquin Road
Schaumburg, Illinois 60196 U.S.A.
Phone: 312-576-6492
TWX: 910-693-0869
Telex: 722443 or 722424
Cable: MOTOL PARTS

5.5 FACTORY ADDRESS FOR CRYSTAL, CHANNEL ELEMENT, ACTIVE FILTER, CODE PLUGS, PROMs, AND RESONANT REED ORDERS

ALL MAIL ORDERS
Motorola, Inc.
Component Products Sales & Service
P.O. Box 66191
O'Hare International Airport
Chicago, Ill. 60666

CORRESPONDENCE
Motorola, Inc.
Component Products Sales & Service
2553 N. Edgington Street
Franklin Park, Illinois 60131

PULSAR IMTS BASE STATIONS (VHF)

PERFORMANCE SPECIFICATIONS

GENERAL

Model	Frequency (MHz)	Maximum RF Output Power	Maximum Input Power	Input Voltage	Input Current (Amps) AC (121 V, 60 Hz) Stby	AC (121 V, 60 Hz) Xmt.	13.6 V dc Negative Ground Stby	13.6 V dc Negative Ground Xmt.
C73RCB1105AS C73RCB1106AS	150.8-160	40-100* Variable (See Notes 1 & 2)	200 W	120 V ±20%, 60 Hz (optional 120/240 V +20%-40% at 50/60 Hz)	Stby .85	Xmt. 5.46	Stby 1.5	Xmt. 26.0

No. of Frequencies:	Single freq. station (dc or tone remote control) Carrier Squelch
Metering:	Metering module with associated selector switches, provides resonant indication of all receiver, exciter, and power amplifier circuits essential to tuning and checking. Telephone jacks (309) are provided for telephone line testing. Panel mounted wattmeter provides indication of forward and reverse power, both F-Zero and full power.

TRANSMITTER

Base Station: Antenna Connector	Type N male
RF Output Power	40-100 W Variable (See Notes 1, 2)
Output Impedance	50 ohms
Oscillator Freq. Stability	Channel elements maintains oscillator freq. within ± .0005% from -30°C to +60°C ambient (+25°C ref)
Transmitter Side-Band Noise	90 dB @ ±30 kHz 105 dB @ ±1 MHz
Spurious and Harmonics	More than 85 dB below carrier
Modulation	15F2 and 16F3 ±5 kHz for 100% at 1000 Hz
Audio Sensitivity	0.120 volt ±3 dB for 60% maximum deviation at 1000 Hz Remote Telephone Line: -25 dBm max. for 60% maximum deviation at 1000 Hz
FM Noise	55 dB below 60% system deviation at 1000 Hz
Audio Response	+1, -3 dB from 6 dB/octave, pre-emphasis, 300-3000 Hz, referenced to 1000 Hz
Audio Distortion	Less than 2% at 1000 Hz; 60% system deviation
FCC Designation	40-100 W CC3249 F Zero CC3244

RECEIVER

Channel Spacing	30 kHz
EIA Modulation Acceptance	±7 kHz minimum
Oscillator Frequency Stability	Channel element maintains frequency ± .0005% from -30°C to +60°C ambient (+25°C reference)
Sensitivity 20 dB Quieting EIA SINAD	(See Note 3) Less than 0.5 uV Less than 0.35 uV
Intermodulation — EIA SINAD	80 dB
Spurious and Image Rejection	100 dB min.
Squelch Sensitivity — Carrier Squelch (adjustable)	(See Note 3) 0.20 uV at threshold
Audio Characteristics — Remote Control Models	Telephone Line: Output: +11 dBm at 600 ohms Response: + 1, -3 dB Distortion: 3% at 1000 Hz Hum & Noise: 55 dB For Local Speaker: Output Available: 10 watts at 8 ohms
RF Input Impedance	Nominal 50 ohms

CONTROL

	Voltage Control	Tone Control
Type of Operation	DC currents detected by Optocouplers	Tone encoder and decode
Type of Telephone Lines	Voice grade with DC continuity	Voice grade — DC continuity not required
Number of Telephone Lines Required	2 pair	2 pair
Line Termination Impedance	600 ohms	600 ohms
Line Insertion Loss (Max. — Station to Terminal)	10k ohms	N/A
Station Control Functions:		
Transmit Full Power	+3 mA	1550 Hz*
Transmit F-Zero	-3 mA	1450 Hz*
Transmit Verification	8.2k ohms impedance change	1550 Hz (full power) 1450 Hz (F-Zero)
Receive Indication	RQS currents — 2 mA at 0 dBq to 10 mA at 40 dBq	2375 Hz * Requires pilot tone of 2432 Hz to maintain base-to-terminal connection
Alarms — Full Power Mode		
Power Loss	Removal of impedance change	1550 Hz
Lack of Modulation	None	1550 Hz

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

NOTES:

1. Optional attenuator allows minimum output power of 20 watts.
2. 40-100 W variable power is licensed under FCC Rules 21, 89, 91.
3. Maximum output power is 100 watts minus the insertion loss of any options used. Refer to the Options Insertion Loss table.
4. Receiver and squelch sensitivity is measured at the receiver input terminal.

With inclusion of F-Zero and wattmeter max. power out is 90 W. (96 W with wattmeter only.)

MOTOROLA

MODEL CHART

FOR VHF

"MICOR" IMTS

BASE STATIONS

CODE:

[X] = ONE ITEM SUPPLIED

[.] = INDICATES MODEL SERIES, SPECIFIC MODEL DEPENDS UPON CARRIER FREQUENCY.

C73RCB-1105AS	C73RCB-1106AS	MODEL NUMBER	DESCRIPTION
			TRANSMITTER
X	X	TLD1690E *	RF POWER AMPLIFIER (110 W)
X	X	TLD2062A	EXCITER BOARD AND FILTER
			TLD5322B EXCITER (150.8-174 MHz)
			TFD6112A EXCITER FILTER KIT
X	X	KXN1019B	TRANSMITTER CHANNEL ELEMENT
X	X	TRN8342A	TRANSMITTER SHIELD
X	X	TRN8222A	POWER COUPLER
			RECEIVER
X	X	TLD8270B *	RECEIVER RF AND IF BOARD
X	X	TRN6006A, AV	AUDIO AND SQUELCH BOARD
X	X	TLN4290B	AUDIO POWER AMPLIFIER
X	X	TLN5903A	RECEIVER SHIELD
X	X	K1005A	RECEIVER CHANNEL ELEMENT
			MISCELLANEOUS
X	X	THN6243A	INDOOR CABINET (60-INCH)
X	X	TPN1110B	POWER SUPPLY
X	X	TLD5571A	WATTMETER
X	X	TLN1956A	F-Ø KIT (VHF IMTS)
X	X	TKN6581A	RF CABLE KIT
X	X	TKN6883A	REPEATER CABLE KIT
X	X	TLN5896A	RECEIVER HARDWARE KIT
X	X	TRN8686A	CARD PULLER
X	X	TRN8694A	TUNING TOOL KIT
			REMOTE CONTROL UNIT
X	X	TCN1292A	UNIFIED REMOTE CONTROL CHASSIS
			TRN8218A INTERCONNECT BOARD
			TLN5646A RECEIVER INTERCONNECT BOARD
			TRN8219A TRANSMITTER INTERCONNECT BOARD
			TKN6570A RF CABLE KIT, RECEIVER
			TRN8220A CHASSIS HARDWARE KIT
X	X	TLN5938A	STATION LINE DRIVER MODULE
X	X	TLN5939A	STATION CONTROL MODULE
X		TLN5940A	TONE FUNCTION DECODER MODULE
X		TLN1946A	PILOT TONE DECODER MODULE
	X	TLN5943A	DC FUNCTION DECODER MODULE
	X	TLN5944A	RQS DETECTOR MODULE
	X	TLN5946A	RQS CURRENT GENERATOR MODULE
X		TRN6085B	ENCODER MODULE
X	X	TLN1873A	METERING MODULE

EPS-26636-B

MOTOROLA

MODEL BREAKDOWN CHART

FOR

VHF IMTS STATIONS

132-174 MHz

CODE:

[N] = QUANTITY OF ONE SUPPLIED

MODEL	DESCRIPTION	TCN1292A	TLD1693E	TLD1694E	TLD2062A	TLN1873A	TLN1956A	TLN1946A	TPN1110B	TPN1165A
		VHF IMTS CONTROL CHASSIS	RF POWER AMPLIFIER (110 W)		EXCITER BOARD & FILTER	VHF IMTS METERING	VHF IMTS F ZERO KIT	PILOT TONE DECODER MODULE	POWER SUPPLY	
		CONTROL CHASSIS	POWER AMPLIFIER (110 W)	POWER AMPLIFIER (110 W)	EXCITER AND FILTER KIT	METERING CHASSIS	VHF IMTS F ZERO	PILOT TONE DECODER MODULE	POWER SUPPLY	POWER SUPPLY
	VHF IMTS CONTROL CHASSIS									
TLN5646A	RECEIVER INTERCONNECT BOARD	X								
TRN8218A	INTERCONNECT BOARD	X								
TRN8219A	TRANSMITTER INTERCONNECT BOARD	X								
TKN6570A	RECEIVER RF CABLE	X								
TRN8220A	HARDWARE KIT	X								
	RF POWER AMPLIFIER (110 W)									
TFD6102A	HARMONIC FILTER		X	X						
TLD5953A	POWER AMPLIFIER HI POWER		X							
TLD5954A	POWER AMPLIFIER HI POWER			X						
TLD5960A	POWER CONTROL BOARD		X	X						
TLN4780A	POWER AMPLIFIER CASTING & HARDWARE KIT		X	X						
TLN5604A	POWER AMPLIFIER HARDWARE KIT		X	X						
TLN8012A	BRACKET		X	X						
TRN6445A	RESISTOR-CAPACITOR NETWORK (150.8-162 MHz)		X							
TRN5502A	RESISTOR-CAPACITOR NETWORK (162-174 MHz)			X						
	EXCITER BOARD & FILTER									
TLD5322B	EXCITER BOARD HI-BAND				X					
TFD6112A	EXCITER FILTER KIT				X					
	VHF IMTS METERING									
TLN5956A	METERING CHASSIS					X				
TLN5957A	METERING CHASSIS & HARDWARE KIT					X				
TLN5958A	METERING SUPPORT BOARD					X				
	VHF IMTS F ZERO KIT									
TLN4640A	RF SWITCH KIT (3 REED)						X			
TKN6894A	VHF CABLE KIT						X			
TLN5954A	HARDWARE KIT						X			
	PILOT DECODER MODULE									
TLN5941A	PILOT DECODER							X		
TLN8209A	VIBRASPONDER							X		
	POWER SUPPLY									
TLN5122A	REGULATOR BOARD								X	
TKN6656A	CABLE KIT								X	
TLN5123B	CHASSIS AND HARDWARE KIT									X
TLN5601A	CHASSIS AND HARDWARE KIT									X

EPS-28441-A

VHF IMTS Factory Installed Options

OPTION	ADD	DELETE	APPLICABILITY (Publication Reference)
C19AA	Duplexer	Nothing	All Stations
C28AF	TPN1106A Power Supply	TPN1110B Power Supply	All Stations (68P81104E92)
C31CT	Nothing	VHF Receiver	Tone Stations
C31CS	Nothing	VHF Receiver	DC Stations
C36AL	THN6385A 75-Inch Outdoor Cabinet	THN6243A 60-Inch Indoor Cabinet	All Stations (68P81033E42)
C38AE	TPN1105A Power Supply	TPN1110B Power Supply	All Stations (68P81104E92)
C47AA	Nothing	TLE5571A VHF Wattmeter	All Stations
C181AC	T1485AF 2 Cavity P/R Duplexer	Nothing	All Stations (68P81102E85)
C182AC	T1487AF 4 Cavity P/R Duplexer	Nothing	All Stations (68P81102E85)
C192AA	TMN6067A Handset	Nothing	All Stations (68P81102E59)
C194AB	THN6385A 70-Inch Upright Cabinet	THN6243A 60-Inch Cabinet	All Stations (68P81033E42)
C257AA	TPN1165A 120/240 V 50 Hz Ferro Power Supply	TPN1110B Power Supply	All Stations (68P81041E49)
C260AA	TLD5561A RF Power Attenuator	Nothing	All Stations
C265AA	TLD5541A One Isolator	Nothing	All Stations
C287AA	TLD5551A Two Isolator	Nothing	All Stations
C288AA	Nothing	TLN1956A FØ	All Stations
C292AA	TLN5948A Sub-Audible Paging Module	Nothing	All Stations (68P81041E47)
C319AA	VHF Receiver and RQS Modules	Nothing	DC Stations
C601AA	KXN1018C Transmitter Element	KXN1019B	All Stations
C621AA	K1006A Receiver Element	K1005B	All Stations

Options Insertion Loss (Nominal Values)

OPTION	DESCRIPTION	INSERTION LOSS
C19AA	Duplexer	0.93 dB
C47AA	VHF Wattmeter (Delete Option)	0.16 dB
C181AC	Two-Cavity P/R Duplexer	0.92 dB
C182AC	Four-Cavity P/R Duplexer	1.72 dB
C265AA	Isolator	0.92 dB
C287AA	Two Isolators	1.62 dB
C288AA	FØ (Delete Option)	0.36 dB (High Power) 0.34 dB (Low Power)

NOTE
A built-in wattmeter and FØ module are standard items.

GENERAL SAFETY INFORMATION

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard which applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station, microwave and rural telephone rf equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Refer to the appropriate section of the product service manual for additional pertinent safety information.

EPS-28750-O

1. INTRODUCTION

The Motorola Pulsar IMTS base station FM two-way radio is fully solid state incorporating integrated circuits. It is designed as the base radio in an IMTS system and offers full duplex operation (can transmit and receive simultaneously) with 4-wire audio. The station uses either dc remote control which is compatible with an IMTS telephone terminal or tone remote control which requires the use of an IMTS interface unit. These stations, which operate in the 150.8-160 MHz frequency range, are equipped for operation on 120 V ac, 60 Hz power. With optional power supplies, operation on 120/240 V ac, 50 Hz power is also possible.

This base station operates on a single frequency with an output power that can be power-set from 40 to 100 watts. The receiver provides 10 watts of audio at less than 5% distortion into an 8-ohm load.

An unheated, temperature compensated, plug-in oscillator module (channel element) is used for frequency control. Because of heatsinking and low heat, no blowers are required. The continuous duty transmitter operates at full rated power indefinitely.

2. MECHANICAL & SERVICING FEATURES

Virtually all components are mounted on circuit boards which are easily removed and replaced without unsoldering leads. The transmitter, receiver and remote control unit are individually mounted on a unified chassis which is fastened to the mounting rails. Interconnecting printed circuit boards then electrically connect these units. The power supply mounts in its own space within the overall mounting rack.

Metering receptacles in the exciter, power amplifier, power control board and receiver rf and i-f can be monitored from the built-in metering module. This allows convenient metering of the various test points during alignment or for rapid isolation of trouble.

All station alignment is performed from the front. Crystal filters in the receiver i-f section eliminate most i-f alignment adjustments.

3. APPLICATION

3.1 GENERAL

This base station is the fixed point from which car telephone calls are sent and received from the mobile radios of the communications system. These remotely controlled stations may be located at the most advantageous point for rf propagation, such as the top of a tall building or a mountain peak, while the telephone terminal may be located elsewhere.

3.2 DC REMOTE CONTROL SYSTEMS

In dc remote control systems, a wire line connects between the base station and the remote IMTS telephone terminal. Received audio from the base station is sent over the receive phone line to the IMTS telephone terminal. Likewise, transmit audio from the terminal is sent over the transmit phone line to modulate the base station transmitter rf carrier signal. The IMTS terminal generates the current necessary to key the base station. Circuits in the base station detect the dc current and perform the necessary keying and control functions. Since the transmit audio line also carries a dc current, the wire line pair between the terminal and the base station must have dc continuity. The receiver audio line also requires dc continuity. During reception of an rf signal, the station generates a dc current that is proportional to receiver quieting (a measure of received signal

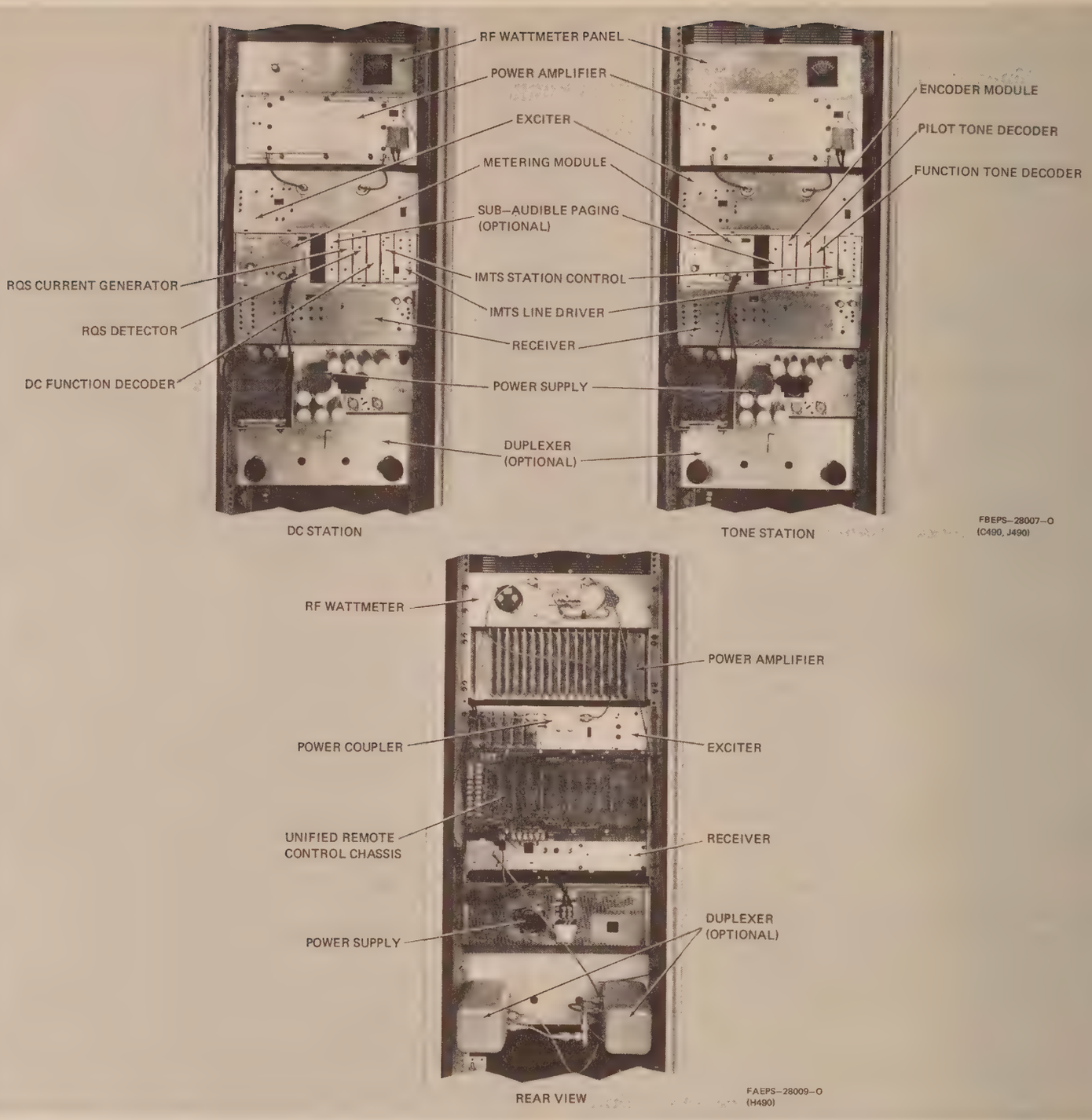


Figure 1. Typical Station with Locations of Major Components and Assemblies

quality). The dc current is carried by the receive audio line to the IMTS terminal.

3.3 TONE REMOTE CONTROL SYSTEMS

Tone remote control allows operating over much greater distances, however these systems require the addition of an interface unit. This unit, which is normally installed at the telephone terminal site, processes tone control information to and from the base station equipment and dc control information to and from the telephone terminal. DC continuity is required between the telephone terminal and the interface but any suitable audio path can be used between the interface and the system transmitters and receivers. Audio between the telephone terminal and the base station (or receivers) is unaffected by the interface unit.

4. DESCRIPTION OF ITEMS

4.1 TRANSMITTER

The transmitter generates a frequency modulated rf carrier signal between 40-100 watts (variable power

set). The station may also be operated in the F-zero mode which bypasses the rf power amplifier and couples the exciter output (less than 1 watt) to the antenna. This mode, which reduces possible intermodulation interference at multiple transmitter sites, can be selected remotely via the control lines or locally by the F-zero switch.

- Channel Element — An unheated, temperature-compensated crystal oscillator plug-in module (channel element) provides a stable fundamental rf frequency for the transmitter. One channel element is used for each transmitter frequency.

- Exciter — The exciter provides the low power excitation signal for the transmitter. An "IDC" (Instantaneous Deviation Control) circuit amplifies and limits audio signals from the control line to prevent over deviation. Amplified audio is applied to the channel element to produce direct fm modulation. Multipliers in the exciter multiply the channel element frequency 12 times to generate an output frequency signal(s) in the 150 to 171 MHz band.

- Bandpass Filter — The bandpass filter couples 150.8-160 MHz signals from the exciter to the power amplifier and attenuates any harmonics outside this band.

- Power Amplifier — The low power output of the exciter is amplified to the rated power output of the transmitter in this solid-state power amplifier. Class C amplifiers are used which are cut off until signal drive is applied. A controlled amplifier stage regulates the amount of signal drive to prevent over-dissipation in the final amplifier stages. An input from the power control board controls the amount of gain.

- Power Control Board — The power control board automatically and instantaneously regulates the transmitter output power. It maintains output power should source voltage vary, and progressively reduces power when the VSWR increases. The output of the board is applied to the controlled amplifier stage in the power amplifier to regulate the amount of gain.

4.2 RECEIVER

The receiver accepts rf carrier signals on a specific channel in the 150.8-160 MHz range and provides voice audio in the 300-3000 Hz range. The receiver consists of the following items:

- Channel Element — A plug-in crystal oscillator module (channel element) provides stable frequency control for the frequency of operation. One channel element is required for each receiver frequency.

- Receiver RF & IF Board — The single-conversion superheterodyne FM receiver includes a preselector (comprised of six cavities) and two crystal filters for excellent selectivity. Two integrated circuit i-f amplifiers and limiters give high sensitivity. A crystal discriminator demodulates the audio directly from an 11.7 MHz i-f signal. An AFC voltage is derived from the discriminator circuit which is used to correct the channel element frequency to provide an overall receiver stability of ±0.0002%.

- Audio & Squelch and Audio Power Amplifier Boards — Up to 10 watts of audio power at less than 5% distortion is provided by this circuit. When no messages are being received, the squelch circuit turns off the audio amplifiers to eliminate annoying noise in the speaker. A squelch tail eliminator circuit prevents the noise burst at the end of a message for strong signals. For weak signals, the circuit is automatically inhibited to prevent loss of portions of messages. The audio power amplifier transistors are mounted on a separate circuit board and aluminum heat sink for good heat dissipation.

- Receiver VOLUME and SQUELCH controls are located on the receiver chassis (all other operational circuits and their controls are on plug-in modules inserted into the unified control chassis). The RECEIVER VOLUME control only affects local speaker operation (when used).

NOTE

The SQUELCH control affects local and remote operation.

4.3 POWER SUPPLY

The power supply normally installed in these stations, utilizes a ferro-resonant (constant voltage) transformer and provides all the voltages necessary for operating the station. It automatically corrects for changes in load and input voltage thus maintaining a constant voltage output. Other optional supplies are available which provide automatic emergency power (+12 V) reverting and international primary power (120/240 V ac, 50 Hz) operation.

4.4 REMOTE CONTROL UNIT

The remote control unit permits remote operation of the base station through the station control, line driver and dc function decoder or pilot tone decoder and tone function decoder plug-in modules. The remote control chassis also provides mounting for the metering module and other modules used in the station.

4.4.1 Remote Control Modules

4.4.1.1 IMTS Line Driver Module

The line driver module accepts remote audio from the incoming phone lines, amplifies it and sets the audio level input to the exciter. In addition, this module also accepts receiver audio and amplifies it before application to the outgoing phone lines.

4.4.1.2 Station Control Module

The station control module provides the necessary integration of control functions from other remote control modules to key the transmitter. It also contains a LINE DISABLE switch which can be used to prevent the remote control point from keying the transmitter.

4.4.1.3 DC Function Decoder Module (DC Stations)

The dc function decoder converts 2.0 mA dc line current into a control function which keys the transmitter. This current originates at the IMTS terminal either by the terminal operator or automatically if the terminal is automatic.

4.4.1.4 Pilot Tone Decoder Module (Tone Stations)

The pilot tone decoder converts a 2432 Hz pilot signal from the interface unit to a push-to-talk voltage. The decoder also amplifies and distributes received function tones to the tone function decoder module. This module also contains the transmit notch filter which prevents pilot tone from modulating the transmitter.

4.4.1.5 Tone Function Decoder Module (Tone Stations)

The tone function decoder module detects either the 1550 Hz or 1450 Hz tone signal from the interface unit and produces switch functions to select either F1 or F-zero modes respectively. A switchable oscillator on this module produces the talk back tone (TBT) during the proper interval to acknowledge the receipt of the tone signals. The module also contains an idle tone detector which produces pulses at 2-second (approx.) intervals when idle tone is present. These pulses are used to enable the oscillator which produces intermittent bursts of status tone (status report).

4.4.1.6 Encoder Module (Tone Stations)

The encoder provides a status tone whenever the receiver is squelched. Status tone is turned off when the receiver is unsquelched. The module can also be used to generate high (2500 Hz) and low (400 Hz) test tones for use in equalizing audio response over the telephone line (or other path). An equalizer in the audio control module can be set (via jumpers) to add gain at either or both of the test frequencies.

4.4.1.7 Subaudible Paging Module (Optional)

This module permits sub-audible paging without requiring expensive conditioning of the telephone lines connecting the paging terminal to remote transmitters. This is done by sending the paging tones multiplied by eight to the remote transmitters and dividing these tones by eight at the remote site.

4.4.2 Receiver Quieting Sensitivity (RQS) (DC models only)

The RQS detector samples the receiver noise output from the discriminator and converts this into a direct current which is inversely proportional to the noise level. The current is then fed back over the receive phone lines to the IMTS terminal. The magnitude of this current is an indication of receiver audio quality. The RQS circuitry consists of two plug-in modules, RQS Detector and RQS Current Generator.

4.4.2.1 RQS Detector

The RQS detector contains two noise sampling channels which are then summed in the output. One channel is tuned to amplify the 4200 Hz portion of the noise spectrum and the other is tuned to the 4800 Hz portion of the noise spectrum. The noise input then produces a dc output that is proportional to the input. The RQS detector contains two variable controls to set the dc output for a given noise input.

4.4.2.2 RQS Line Current Generator

The RQS line current generator provides a direct current over the receive phone lines. This current is proportional to the dc voltage received from the RQS detector. A level control sets the output current for a given input dc voltage.

4.4.3 Metering Module and Jackfield

4.4.3.1 Jackfield

The jackfield is located on the line driver module (TLN5938A). The jackfield consists of seven jacks. The uppermost jack is used to monitor the exciter input level, and is labeled XCTR LEVEL. The remaining six jacks are divided between the receiver and transmitter, three each labeled STA, BRIDGE and LINE. One set is used for monitoring the transmit remote input lines and the other set is used for monitoring the receiver remote output lines. The LINE jack disconnects the remote lines from the transmitter or receiver, depending upon which set of jacks is being used, and allows test equipment to substitute for the remote operator. The STA jack disconnects the transmitter and receiver from the remote lines and allows the test equipment to substitute for the transmitter or receiver. The BDGE allows the test equipment to bridge the line for checking levels or a telephone handset to bridge the line during maintenance.

4.4.3.2 Metering Module

The TLN1873A Metering Module is plugged into the unified chassis. It gives the operator the ability to monitor various sections of the base station. To test a particular section the operator must insert the meter plug in the appropriate 8-pin jack and select that section

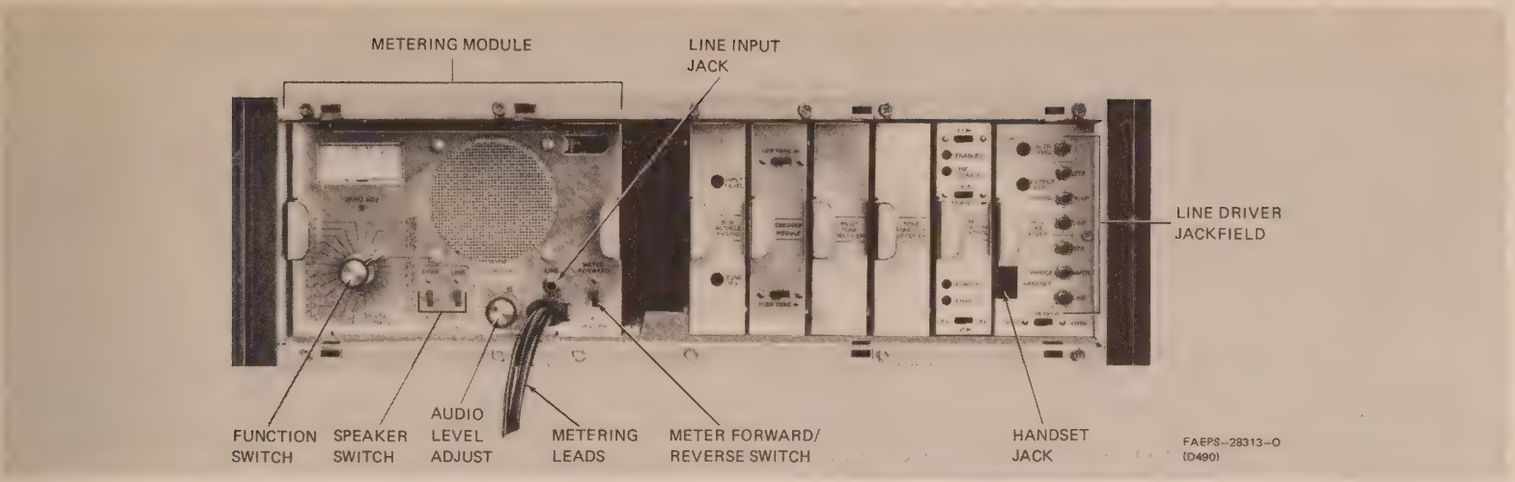


Figure 2. Metering Module and Line Driver Jackfield Detail

on the function switch located on the meter panel. Also included are test leads (2) for use when using the metering module as a voltmeter.

5. FUNCTIONAL DESCRIPTION

To analyze overall station functional operation, refer to the functional block diagrams at the end of this section.

5.1 GENERAL

There are two basic operation modes in this station; transmit and receive. The station is capable of transmitting and receiving simultaneously on a 100% transmit duty cycle. One of the basic functions of this station is to provide a means for accepting a remote dc signal and audio which will key and frequency modulate the transmitter. Another basic function is to receive an incoming rf signal, demodulate it and furnish the audio to the remote terminal.

The basic function of the remote control is to allow operation of a base station from a remote terminal. Two basic types of remote control comands are used for base station control; dc control and tone control; however, a compatible remote terminal must be used at the control point in order to control the station. DC control uses dc current of varying magnitude and polarity to initiate the various control functions such as transmitter keying. The wire line pair must have dc continuity to be used with a dc remote control system. In some areas, telephone line pairs with dc continutity are not available. Tone control uses audio tones of various frequencies to initiate the control functions. The audio tone used for transmitter keying is filtered out of the transmit audio so that the tone is not transmitted. Other commands require only a momentary application of the tone command to initiate the desired mode of operation. The wire line pair need not have dc continuity for tone remote control operation. The station unified chassis can accept plug-in modules for dc or tone control. This feature allows a station to be easily converted from one type of control to the other, if necessary.

5.2 DC CONTROL

A dc control station requires the following modules:

-- IMTS Line Driver
-- IMTS Station Control
-- DC Function Decoder
-- RQS Detector
-- RQS Current Generator
-- Sub-Audible Paging (optional)

5.2.1 Station Keying

When a transmit command occurs at the remote IMTS terminal a +2.2 mA control line current is applied via the remote transmit phone lines to TB1-4 and TB1-6 of the main interconnect board (rear of remote control chassis). After passing through the XMTR jacks of the line driver jackfield, the signal is applied to T1. The current passes through T1 to pins 17 and 18of the line driver module to pins 17 and 18 of the dc function decoder module, via the remote chassis interconnect board.

The current is sensed by F1 detect opto-coupler U1; turning on Q1, Q2, and Q3; and initiating line PTT (pin 14) and a high at pin 4 (F1 key). The low, line PTT, appearing at pin 14 is routed from the dc function decoder (on the remote control interconnect board) to pin 14 of both the station control module and the optional sub-audible paging module. With pin 14 low and pin 4 of the dc function decoder module high, the F1 bistable of the station control module goes high and stores F1.

When F1 is stored, the keyed A+ and keyed A- outputs of the station control module apply operating voltages to the exciter and power amplifier. These outputs are at pins 5 and 13 respectively and are routed on the remote chassis interconnect board to pins 25 and 26 of the transmitter interconnect board. Q5 of the station control module turns on and activates the FØ kit relay. This allows the output of the exciter to be applied to the power amplifier.

The transmitter will not key until the channel element is activated. Activation of the channel element occurs whenever Q10 of the station control module conducts. The low (Q10 conducting) is applied to the exciter where it activates the channel element.

Once keyed, the rf carrier is generated in the exciter, amplified, and applied via shielded cable through a bandpass filter and the FØ kit to the power amplifier.

5.2.2 Receiver Quality Signal (RQS)

The RQS detector samples the receiver noise output from the discriminator and converts this into a direct current which is inversely proportional to the noise level. The current is then fed back over the receive phone lines to the IMTS terminal. The magnitude of this current is an indication of receiver audio quality.

5.2.2.1 RQS Detector

The RQS detector module generates a voltage that is proportional to receiver quieting and applies it to the RQS current generator. During signal reception a portion of the discriminator output is routed to pin 10 of the RQS detector.

The signal from the discriminator contains noise in the audio range which is amplified by U1D and applied to the two noise sampling channels (one channel passes the 4200 Hz portion and the other passes the 4800 Hz portion of the noise spectrum). Each sampling channel contains a threshold adjust, a 2-cell LC circuit, a two stage amplifier that provides 48 dB gain, a peak detector, and a voltage follower as the output stage. The output of each channel is applied to U1C; the signals are summed together and applied to the RQS current generator.

5.2.2.2 RQS Current Generator

The RQS line current generator provides a direct current over the receive phone lines, that is, proportional to the dc voltage received from the RQS detector. The input to the module (pin 4) is applied to an emitter follower (Q4) which supplies power to the Q5, Q6 astable. The free running astable developes a 70 kHz square-wave signal, whose amplitude is dependent upon the output of Q4. Amplifier Q7 accepts the astable output and applies it to the peak detector and the Darlington buffer (Q8, Q9) of the module. The output of the Darlington pair provides the drive for the output current control (Q10).

The free-running 10 kHz oscillator (Q1, Q2), bridge rectifier, and integrator develops the 125 V/60 V dc that is routed to the terminal. Part of this output is used to develop the regulated 26.4 V dc used in the module.

The outputs of the module (pins 9, 10) apply the control current to the line driver (pins 9, 10). These signals are then routed to the remote control chassis interconnect board (TB1-1 and TB1-3) for output to the remote phone lines.

5.3 TONE CONTROL

5.3.1 Tone Control Format for IMTS

Tone control uses audio tones of various frequencies to initiate the control functions. The audio tone used for transmitter keying is filtered out of the transmit audio so that the tone is not transmitted. Other commands require only a momentary application of the tone to initiate the desired mode of operation. The wire line pair need not have dc continuity for tone remote control operation. Refer to Table 1 for a listing of the remote control tones used in this system.

Table 1. Control Tones

Designation	Frequency	Duration	Source
PILOT TONE High Level — Low Level	 2432 Hz 	115 msec — present with the audio signal	 Interface
FUNCTION TONE FØ — F1	1450 Hz — 1550 Hz	40 msec	Interface
TALK-BACK-TONE FØ — F1	1450 Hz — 1550 Hz	50 msec	Base Station
STATUS REPORTS (sent only when station is keyed on F1 and idle tone is present)	1550 Hz	50 msec bursts sent at 2 sec intervals	Base Station
ALARM TONE FØ — F1	 — 1550 Hz	400 msec	Base Station
STATUS TONE	2375 Hz	whenever the receiver is squelched	Base Station

The modules required in a tone control station are:

— IMTS Line Driver
— IMTS Station Control
— Tone Function Decoder
— Pilot Tone Decoder
— Encoder Module
— Sub-Audible Paging (optional)

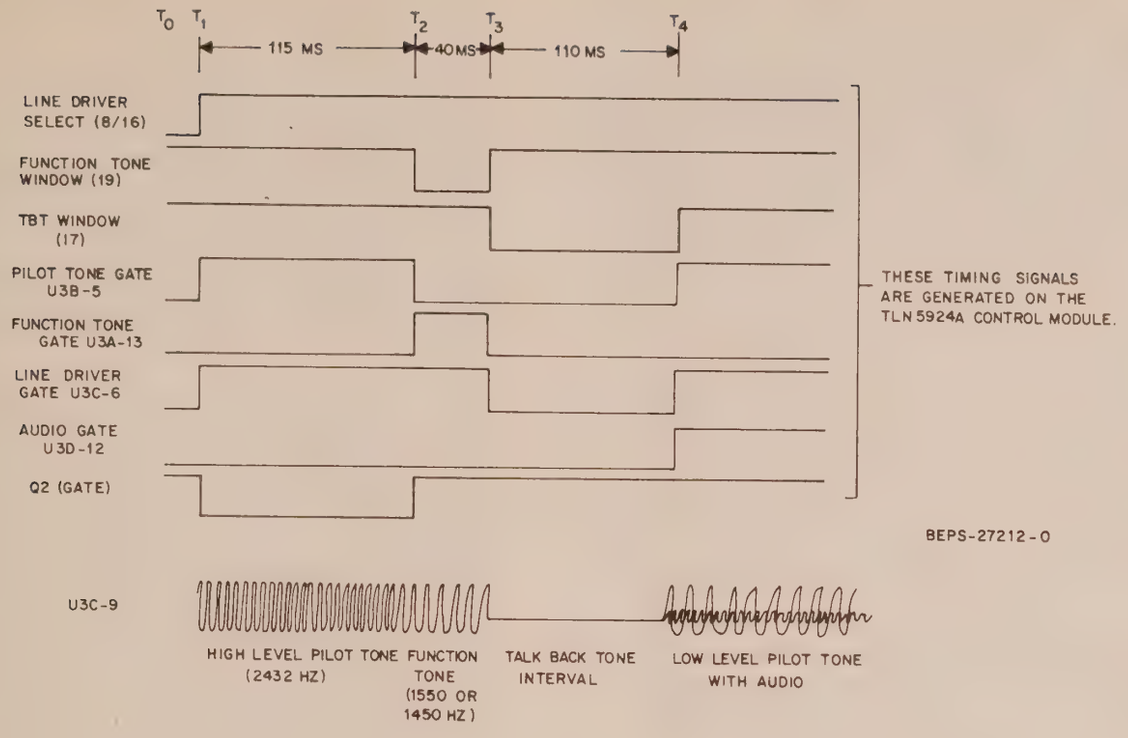


Figure 3. Timing Intervals Generated by the Tone Remote Control Interface Unit

NOTE

The tone station must be used with the tone interface unit, connected between the dc control terminal and the base station.

5.3.1.1 Pilot Tone

Upon receiving a key-up command from the terminal, the interface will generate a tone sequence to key-up the base station in the mode selected by the terminal. The key-up sequence is initiated by a 115 msec burst of high level pilot tone (2432 Hz). The tone is decoded in the pilot tone decoder which then generates line PTT. Next the function tone is sent for 40 msec, followed by low level pilot tone. This completes the key-up sequence. The station will remain keyed until low level pilot is removed by the interface.

During audio transmission, the interface unit generates the pilot tone. This tone is sent at a low level with the audio signal. Before transmission by the station, the low-level pilot tone is filtered out IN the pilot tone decoder module.

5.3.1.2 Function Tones

The function tones are generated in the IMTS interface equipment. The tone is generated for 40 msec at either 1550 Hz for F1 or at 1450 Hz for FØ . These tones select the amount of power output at the base station. F1 select allows the exciter output to be applied to the power amplifier before applying the signal to the antenna. FØ select routes the exciter output directly to the antenna, via the duplexer.

5.3.1.3 Talk-Back Tone

The talk-back tone (TBT) is generated in the base station function tone decoder module. This tone (approximately 50 msec in duration) is an acknowledgement to the interface that the base station has keyed up and is transmitting at the proper power level. The TBT frequency is dependent upon the mode selected at the control point. The station will generate a tone, 1450 Hz for FØ or 1550 Hz for F1, and send it back to the interface unit during the TBT window interval (see Figure 3). The tone is detected by the interface, allowing normal operation. If the station keys up but does not develop proper output power, the TBT duration will be 400 msec instead of 50 msec. Presence of the tone after the TBT window is detected by the interface unit as alarm tone; the interface unit then generates an alarm.

5.3.1.4 Status Reports

Status reports are sent only when the base station is in the F1 mode and idle tone is present. They are

generated in the tone function decoder module, and are sent in 50 msec bursts every 2 seconds. If for any reason the base station stops transmitting idle tone (generated by the terminal), but is still receiving it from the interface, the status reports will cease, causing the interface to generate an alarm. If the base station transmitter fails, a 400 msec burst of tone (1550 Hz) will be sent to the interface, again causing the interface to generate an alarm.

5.3.1.5 Alarm Tone

If the base station receives an F1 command from the interface, but does not respond by putting out rf power at the desired level, alarm tone will be sent back to the interface. Also, if for any reason the rf power output drops below the threshold determined by R103 in the station control module, subsequent to key-up, alarm tone will be sent. In the FØ mode, power output is not monitored, so alarm tone is sent only if the station does not properly decode the FØ command. The only difference between alarm tone and talk-back tone is the duration. Alarm tone is enabled for 400 msec, while TBT lasts for 50 msec.

5.3.1.6 Status Tone

The status tone is produced whenever the station receiver is squelched. The 2375 Hz tone is generated by the station encoder module and is routed from the station to the interface unit via the remote phone lines. Status tone is removed when the receiver is unsquelched.

5.3.2 Station Keying

5.3.2.1 Signal Routing

When a transmit command is generated by the terminal, dc control current is sent to the interface unit. this current originates at the IMTS terminal either by the terminal operator or automatically if the terminal is automatic. The interface decodes the dc currents and generates the equivalent control tones.

The control tones are routed from interface line driver, via the transmit lines to TB1-4 and TB1-6 of the station interconnect board (rear of the remote control chassis). Refer to Figure 3 for sequence of control tones. After passing through the XMTR jacks of the line driver jackfield, the signals are applied to T1 and coupled to the exciter level control (R61) and pin 21 of the module. The signals leaving pin 21 are routed on the chassis interconnect board to pin 21 of the pilot tone decoder module.

5.3.2.2 Pilot Tone Detection

During the pilot tone interval, the 2450 Hz pre-filter of the pilot tone decoder module allows the 2432 Hz pilot tone through amplifiers Q1 through Q4. The output of Q4 is fed to the "Vibrasponder" reed through Q23, to line AGC detector Q10, to activity checker circuit at Q21, and to pin 16 for function tone output to the function tone decoder. The "Vibrasponder" reed allows only pilot tone to be applied to Q5 and Q6 for pilot tone detection. When pilot tone is detected (and not inhibited by Q18) push-to-talk switch Q13 is turned on and provides line PTT at pin 14. Line PTT is routed through the station interconnect board to the function tone decoder module, station control module, and optional sub-audible paging module.

During the presence of pilot or function tone (activity), Q21 will turn on for each positive half of the cycle. The collector of Q21 drives the activity checker, Q20. When activity is detected, Q20 charges C25 and turns off the fast activity checker, Q24. The purpose of Q24 is to bias the pre-filter switch Q16, and the decoder bias switch driver Q17, on, during loss of activity. When C25 charges, Q19 turns on, which turns off Q18; enabling the gated AGC detector, and the function tone detectors. If activity is lost, Q18 will not turn on for 170 msec due to the charge stored in C25. This is to prevent loss of line PTT during brief line interruptions.

When high level pilot tone is sent by the interface, and detected by the pilot tone detector, Q11, Q13 is turned on. Q13 then pulls pin 14 (line PTT) low and turns Q16 and Q17 off for 375 msec by back biasing CR6 and CR9 through C23. When Q16 turns off, the pre-filter is removed from the circuit, allowing function tone to pass through. When Q17 turns off, pin 15 is pulled high, enabling the tone decoders in the tone function decoder module. After function tone is sent, a 115 msec pause occurs (talk-back-tone window). During the pause no activity is present causing Q24 to turn on, which turns on Q16 and Q17. Following the 115 msec pause, low level pilot tone is sent from the interface. Low level pilot tone continues to be sent until the conversation is completed. Loss of pilot tone will turn Q18 on after 170 msec thus turning Q13 off, disabling line PTT and dekeying the station.

5.3.2.3 Function Tone Detection

When pin 15 (function tone window) goes high, Q2 will conduct and enable the tone detectors. This will now allow the selected function tone to pass to the detectors after amplification by Q1. The detection of one of the tones will cause either Q3 or Q4 to conduct, which will present a low at either pin 8 or 4.

Assuming that F1 was selected at the control point, the low at pin 4 will be routed on the interconnect board to pin 4 of the station control module. In the station control module, the low at pin 4, along with the presence of line PTT at pin 14, will enable the F1 bistable. A low at pin 14 (line PTT) turns on Q7 (keyed A+ switch), supplying A+ to the F1 and FØ bistables and output pin 5. Q1 will conduct if the collector of Q13 is high (station not already in FØ mode). The output of

Q1 turns on Q2, latching the bistable. Q1 also turns on DS1, the F1 enabled LED and places a high on pin 19, F1 stored.

The base station will now key-up in the F1 mode. Pin 19 is routed over to pin 19 of the tone function decoder module via the interconnect board. When F1 stored is high, Q6 will conduct thereby switching C12 into the oscillator circuit comprised of Q8 and Q9. With C12 in the circuit, the oscillator will run at 1550 Hz. If FØ stored is high, Q5 will switch C14 into the circuit causing the oscillator to run at 1450 Hz.

5.3.2.4 Talk-Back Tone Generation

TBT is sent to the interface during the TBT window generated by the interface. The window occurs directly after function tone has been sent. The high to low transistion on pin 15 of the function tone decoder module (end of function tone window), starts TBT monostable U3A. A pulse of 50 msec duration will be generated on pin 5 of U3A, and pin 2 of U2A. By the end of the function tone window, the base station will have come up to power, thus putting a high on pin 6 of the module, and on pin 1 of U2A. When pin 1 of U2A goes high, pin 3 will go low and stay low. However, if the base station did not key up, pin 6 (module) will remain low and U2A will invert the pulse appearing on pin 2. The high to low transition on pin 10 of U2C will trigger alarm monostable U3B. Pin 9 of U3B will then pulse high for about 400 msec. Pin 5 of U3A and pin 9 of U3B are the inputs to NOR gate U2D. Pin 11 of U2D will pulse low for 50 msec if U3B is not triggered, and 400 msec if U3B is triggered. With a low on pin 14 (PTT), U2B will enable tone gate Q10 (through inverter Q200) for 50 msec if power came up, or 400 msec if power did not come up. The 400 msec burst of tone is called alarm tone, since it indicates the base station did not come up to power. The tone is amplified by Q13 and routed over to pin 2 of the line driver module, where it is amplified further and then sent via the remote lines to the interface.

If the base station is keyed in the FØ mode, pin 6 of the tone function decoder module is pulled high artificially in the station control module. In other words, it is assumed that the exciter will put out power. Otherwise, the sequence of events for the talk-back tone generation are the same in the FØ and F1 mode.

When the TBT signal reaches the interface unit within the proper time frame, both audio and low level pilot tone will be gated from the interface to the base station. In the absence of the TBT signal within the specified time frame, or if alarm tone is sent, the interface will initiate its alarm functions.

NOTE

In the absence of the low level pilot tone, which is sent with the audio, the base station will dekey.

5.3.2.5 Status Reports

Status reports are sent to the interface only when the base station is in the F1 mode and idle tone is present. When idle tone is detected by Q103 in the tone function decoder module, a high will appear on Q106, enabling status report tone astable U1. U1 then controls tone gate Q10 in the same fashion as NOR gate U2D did in TBT generation. Status reports are sent every two seconds in pulses of 50 msec duration. If idle tone is not detected, even though the interface is in fact sending it, the status reports will cease and the interface will generate an alarm.

5.4 COMMON FUNCTIONS OF DC AND TONE STATIONS

5.4.1 Transmit Audio

Audio from the remote terminal is applied over the same remote phone lines that carried the control signaling commands. The lines connect to TB1-4 and TB1-6 of the main interconnect board (rear of remote control chassis). After passing through the XMTR jacks of the line driver jackfield, the signal is applied to T1. The audio is coupled to Q13 through exciter level adjust R61. The output of Q13 is routed through Q15 to the exciter audio gate Q16 (enabled when F1 is selected), and to the main interconnect board at pin 24 of the module. On DC stations JU5 is in, so audio is routed from pin 13 to pin 24 of the transmitter interconnect board; then to pin 12 of the exciter. On tone stations audio goes from pin 24 on the line driver to pin 24 of the pilot tone module, through the transmitter notch filter, and out on pin 13. The audio is then routed to pin 12 of the exciter.

The exciter input circuit consists of a clipper and splatter filter which is followed by an emitter follower and Instantaneous Deviation Control (IDC). The IDC sets the modulation input to the channel element. The channel element output is a frequency modulated signal which is one-twelfth of the final transmitter frequency. A buffer amplifier, a tripler, two doubler stages, and an output amplifier provide the signal input to the first bandpass filter.

The first bandpass filter is connected between the exciter output and the power amplifier input. This filter prevents frequencies outside of the 150 to 171 MHz range from reaching the power amplifier. The output of the first bandpass filter is coupled to the FØ kit, where the signal can be switched to either the power amplifier (F1 mode) or directly to the antenna (FØ mode) for output.

The PA requires an rf power input of at least 400 mW to produce an output at its rated value (see section 68P81039E38). After amplification, the rf carrier signal passes through the harmonic filter to the directional coupler on the power control board. The output

of the directional coupler is then applied to the wattmeter, and options (isolators, duplexer, etc.) if used, and then to the antenna.

The power control board senses both the forward and reverse rf power, developing dc voltages. The dc voltages are applied to a differential amplifier. The differential amplifier output dc voltage is then amplified in dc amplifier Q601 for application to the control stage of the PA. If the forward power exceeds the threshold setting of the POWER SET control (an indication of too-high output power), the power control stage reduces the gain of the controlled stage of the power amplifier. This action reduces the output of the power amplifier.

5.4.2 Transmitter Dekey

When the transmitter is dekeyed at the remote sites, the following sequence of events occur: (1) In a tone system, pilot tone is removed, and in a dc system, the keying current is removed. As a result, line PTT will go high; (2) In the station control module, when pin 14 (line PTT) goes high, keyed A+ is disabled. This action removes keyed A- to the PA, exciter, and channel element, turning off the transmitter.

The transmitter will also dekey (if programmed to do so by the interface) if the rf power falls below the alarm trip point level. In this case, the power detect output (pin 6) of the station control module goes low initiating the alarm tone sequence.

5.4.3 FØ Mode

In multiple channel mobile telephone systems, the possibility of producing a false channel exists. A false channel can be produced whenever two or more stations, on different channels, are simultaneously transmitting idle tone. A mobile, in close proximity of the sites, may receive the intermodulation (IM) product (with idle tone) developed by the base stations and lock onto it. This prevents the mobile from generating or receiving calls.

In IMTS systems, the possibility of false channel generation is reduced by the implementation of the FØ mode. In this mode, a station remains keyed at a reduced rf output power. The reduced output (carrier only) of the station is sufficient to virtually prevent the mobile from locking onto a false channel. The mobile senses the carrier only, but does not lock onto it for lack of an idle tone.

The FØ mode can be selected at the control terminal (automatically or by the operator) or locally at the base station site. When the FØ mode is initiated, the output of the exciter bandpass filter is switched directly to the antenna (through a relay) without amplification by the PA. The sequence is as follows:

- FØ select current (-2 mA) is sent by the control terminal to either a dc station or the tone interface. The interface generates the appropriate control tones for a tone controlled station.

- The base station decodes the command, then switches the exciter bandpass filter from the PA input (F1) to the antenna through the FØ relay.

5.4.4 Idle Tone

When one or more unused radio telephone channels are available in a particular area, one is automatically selected at the telephone exchange. The base station then transmits the 2000 Hz idle tone on that channel and in this manner is "marked" idle. The mobile units, when turned on, scan over each channel in their complement, detect the presence of the idle tone, and select that channel.

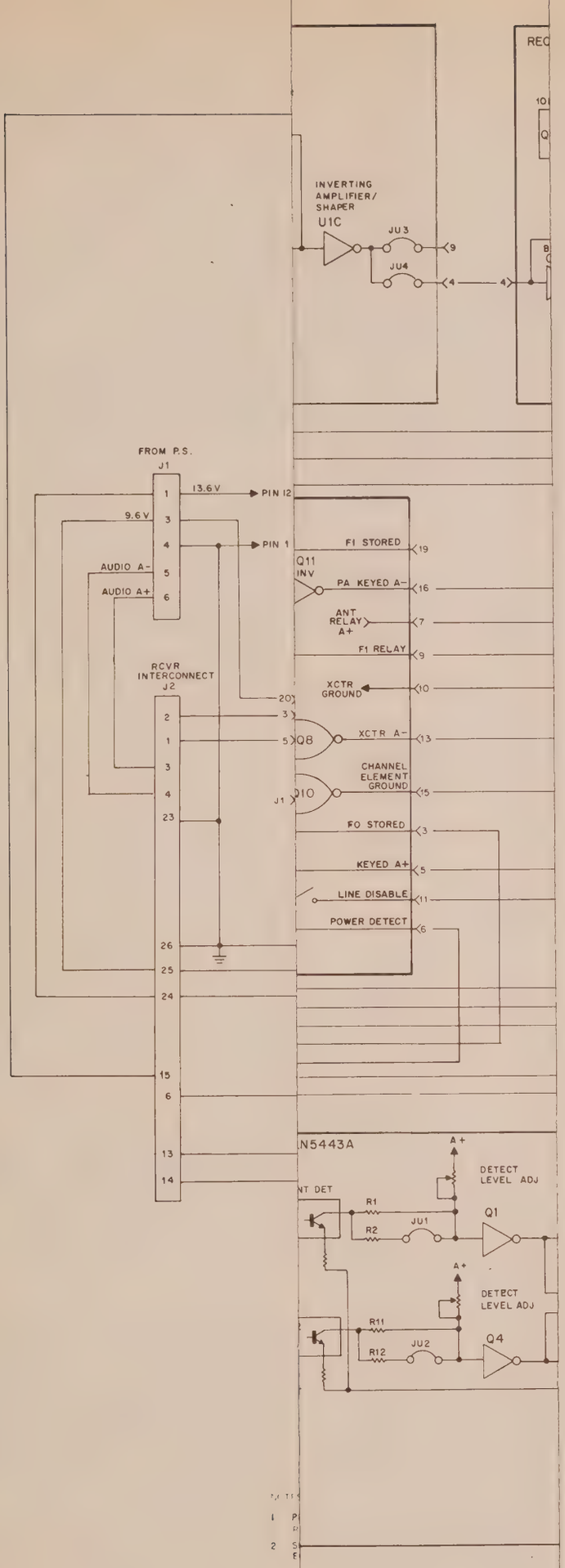
5.4.5 Receive Audio

Received energy is applied to the receiver rf preselector from the antenna via the duplexer. The rf preselector attenuates incoming rf signals which are outside the 150.8-160 MHz range, thus ensuring that high level off-channel signals are not applied to the mixer.

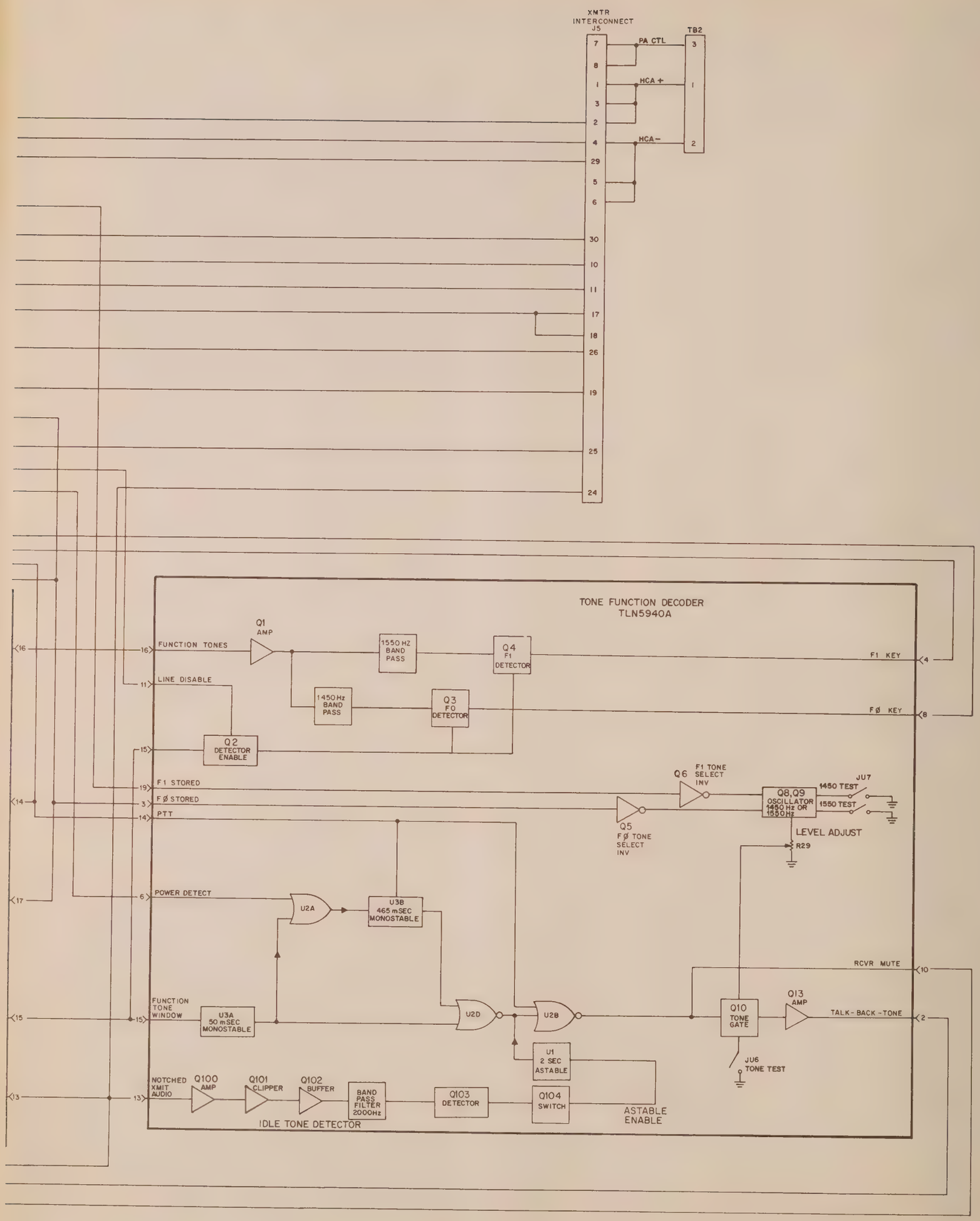
The mixer accepts rf signals from the preselector and local oscillator. The two rf signals are heterodyned, in the mixer, to produce an 11.7 MHz intermediate frequency (i-f). The i-f signal is applied to the first i-f amplifier, through a matching filter, and then to the first four-pole crystal filter. The filter has a high Q, resulting in a narrow bandpass with excellent off-channel signal rejection. From here the signal is routed to the second i-f amplifier, four-pole crystal filter, and finally to the discriminator (includes the limiter).

The output of the second four-pole crystal filter is applied to the discriminator circuit for conversion to audio. The actual discriminator consists of a dual-resonator crystal which provides the required phase shift (similar to the double- tuned transformer). Audio from the discriminator is applied to the Audio & Squelch board.

The audio and squelch board performs two basic functions -- audio amplification and audio squelching. The first two stages in the audio circuitry amplify the signal from the discriminator and provide the proper frequency response. This signal is routed to the line driver module where it is amplified and applied to the remote phone lines.



IMTS Base Station
Functional Block Diagram
DC Remote Control
Motorola No. PEPS-28508-O
(Sheet 1 of 2)
6/15/79-PHI


XMTR INTERCONNECT J5
TB2
PA CTL
HCA +
HCA −
TONE FUNCTION DECODER TLN5940A
Q1 AMP
FUNCTION TONES
LINE DISABLE
1550 HZ BAND PASS
Q4 F1 DETECTOR
F1 KEY
1450Hz BAND PASS
Q3 FØ DETECTOR
FØ KEY
Q2 DETECTOR ENABLE
F1 STORED
FØ STORED
PTT
Q6 F1 TONE SELECT INV
Q8,Q9 OSCILLATOR 1450 Hz OR 1550Hz
JU7
1450 TEST
1550 TEST
Q5 FØ TONE SELECT INV
LEVEL ADJUST
R29
POWER DETECT
U2A
U3B 465 mSEC MONOSTABLE
RCVR MUTE
FUNCTION TONE WINDOW
U3A 50 mSEC MONOSTABLE
U2D
U2B
Q10 TONE GATE
Q13 AMP
TALK-BACK-TONE
U1 2 SEC ASTABLE
JU6 TONE TEST
NOTCHED XMIT AUDIO
Q100 AMP
Q101 CLIPPER
Q102 BUFFER
BAND PASS FILTER 2000Hz
Q103 DETECTOR
Q104 SWITCH
ASTABLE ENABLE
IDLE TONE DETECTOR

INSTALLATION

IMPORTANT

The operation of the transmitter in this radio set is covered by governmental rules and regulations. Several provisions of Federal Communications Commission (FCC) rules are briefly summarized in the following paragraph. For complete information for rules in other countries, refer to the most current applicable regulations.

—Transmitter frequency must be checked before a transmitter is placed in service. While it is not required, it is recommended that the transmitter frequency be checked at the end of the first and third months of service and at one year after installation. This will aid the maintenance technician in detecting frequency changes due to crystal aging. After this initial period, the frequency should be checked once each year. In addition to the frequency check, the transmitter deviation should also be checked and adjusted if necessary.

—The rf power output of a transmitter shall be no more than required for satisfactory technical operation considering the area to be covered and the local conditions.

—Radio transmitters may be tuned or adjusted only by a person holding a valid first or second class commercial radiotelephone operator's license or by personnel working directly under his immediate supervision.

REMEMBER

The efficiency of the equipment depends upon a good installation.

1. INSPECTION

Inspect the equipment thoroughly as soon as possible after delivery. If any part of the equipment has been damaged in transit, report the extent of damage to the transportation company immediately.

2. PLANNING THE INSTALLATION

Since a good installation is so important to obtain the best possible performance of the communications system, carefully plan the installation before actual work is started. Location of the station should be related to power, control lines, and the antenna. Convenience and access for servicing should also be considered. Read the entire procedure and the suggestions offered to help you plan your installation. Make sure all tools, equipment and facilities are available when installation is begun.

3. VENTILATION

The radio equipment is operated without forced ventilation. The cabinet door has openings at the top and bottom, therefore, heated air rising in the cabinet causes a natural draft. It is essential that the door openings be kept free of obstructions so the air flow will not be restricted. The vents on outdoor type cabinets provide necessary station ventilation and in additon prevent rain, snow, etc from entering the cabinet.

4. INSTALLATION OF CABINET

Select the location of the station with the following factors taken into consideration.

—RF transmission lines may enter through the top, bottom or any side of the cabinet. Caution must be used to insure that the area inside the cabinet is unobstructed by chassis, framework, etc.

—Power lines should enter the cabinet at the base (floor).

—Control lines may enter through the base of the cabinet or through an opening in the rear door.

—The cabinet should be placed with adequate clearance at the front and back to allow access doors to open.

—The cabinet must never be allowed to stand in water. If there is a possibility of water on the floor, elevate the cabinet to prevent damage.

5. CONNECTIONS

5.1 GENERAL

All antenna, power and control lines may be brought out through the bottom of the cabinet by drilling a hole in the cabinet at the desired position. Be careful to determine internal clearance before drilling access holes. A 3/4-inch diameter hole allows conduit to be installed for cable runs. For outdoor installations, the entrance point(s) must be sealed and made as weatherproof as possible.

5.2 ANTENNA

Installation of the antennas and transmission lines should be made prior to installation of the station. The antennas and transmission lines are not supplied as part of the station equipment; therefore, antenna installation instructions are not included herein. Follow the instructions shipped with the antennas for applicable antenna installation procedure.

In its primary applications, the station is used for communication with mobile stations. Antennas exhibiting omni-directional characteristics are desirable. However, if the station is located at the outer perimeter of a communications area, of if it is to be used for communications with fixed stations, antennas with specific directional characteristics may be more suitable. FCC requirements may also specify the type of antenna to be used.

The transmit antenna coaxial cable connects to the wattmeter element type N connector. The receive antenna coaxial cable connects to the BNC receiver input connector. If the optional duplexer is used, the antenna coaxial cable connects to the UHF connector on the duplexer.

5.3 POWER CONNECTIONS

All stations may operate on a 20-ampere, 120 volt 60 Hz ac power input. This circuit should be installed in accordance with local electrical codes.

NOTE

240 Volt operation is also available. Refer to the power supply section for details.

The primary ac power line can be installed and terminated in a 120 V ac outlet box near the station site before installing the station cabinet. Once the station cabinet is secured in its operating location, connect the ac power cable from the power supply to the outlet.

WARNING

If a three-wire grounded primary ac power source is not available, the radio equipment *must* be *grounded* separately to prevent electrical shock hazards and provide lightning protection.

5.4 CONTROL LINES

The station can be controlled from a remote point over wire line circuits. Duplex audio is used, meaning that the remote point can send audio to the station or receive audio from the station at the same time (four-wire audio). Therefore, two audio pairs will be required. For dc remote control operation, both wireline pairs must provide dc continuity for carrying the dc control currents. For tone remote control operation the audio pair also carries the control tones. Operating tone remote control stations requires the use of an IMTS interface unit. This unit, which translates the dc commands from the terminal into control tones, is usually installed at the terminal site to minimize the length of lines with dc continuity.

The audio wire line(s) must meet the following specifications for acceptable radio communications.

Audio Line Requirements

Frequency Response: 300 to 3000 Hz
Frequency Translation Error: ± 5 Hz maximum
Impedance: 600-ohm balanced line
Signal-To-Noise: 35 dB minimum
Maximum Loss: Not to exceed minimum station input requirements. DC Continuity (DC control only).

Characteristics of leased telephone lines should be checked with the company providing the service per the above requirements.

The control line may be installed prior to installation of the cabinet and terminated near the location chosen for the station. Conduit or two-wire cable can be used from this termination to the station cabinet.

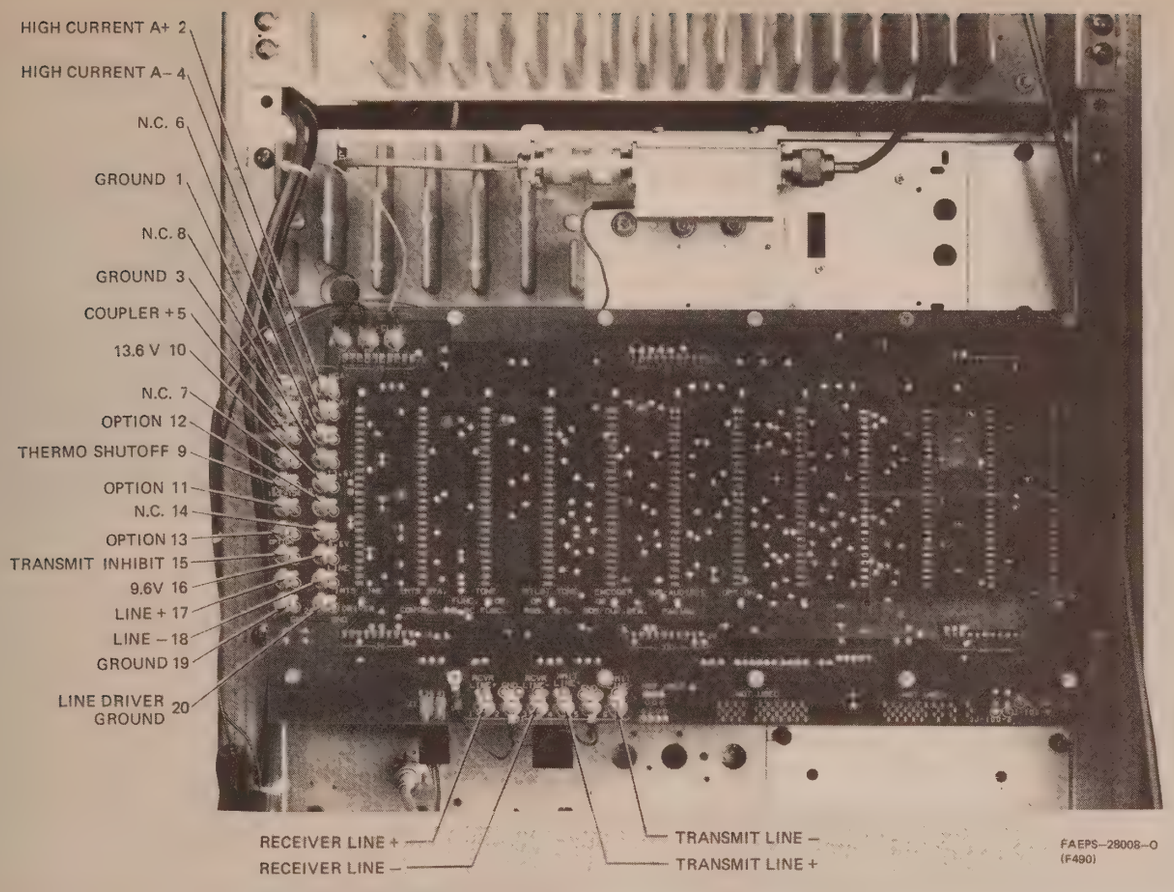


Figure 1. Screw Terminal Locations

5.5 JUMPER CHECKS

Many station modes of operation are determined by jumper connections at the time of installation and are described in the following paragraphs.

Additional jumpers used with the station are identified and described in applicable sections elsewhere within this instruction manual.

5.5.1 Line Driver Module

JUMPER	TONE OPERATION	DC OPERATION
JU1	IN	IN
JU2	IN	IN
JU3	OUT	OUT
JU4	OUT	OUT
JU5	OUT	IN
JU6	IN	OUT
JU7	IN	IN
JU8	IN	IN
JU9	IN	IN
JU10	*	*

* = JU10 is normally out—in for receiver line levels of less than minus 10 dBm.

5.5.2 Station Control Module

	JUMPER				
OPERATION	JU1*	JU2	JU3	JU4	JU5
TONE	IN	OUT	IN	IN	IN
DC**	IN	OUT	IN	IN	IN

* = JU1 may be removed if FØ capability is deleted.
** = DC operation requires the removal of C1, C2, CR2, and CR16.

5.5.3 Tone Function Decoder Module

JUMPER	JU1	JU2	JU3	JU4	JU5
STATUS	IN*	IN	IN	OUT	IN

*JU1 may be removed for delete FØ option.

5.5.4 Pilot Tone Decoder Module

JU1 is IN only for inputs to the transmit line exceeding 0 dBm.

5.5.5 DC Function Decoder Module

JUMPER	JU1	JU2	JU3	JU4	JU5	JU6	JU7
STATUS	IN*	IN	IN	OUT	IN	**	***

*May be removed if FØ option is deleted.
**Normally on standard position (connected to ground pin when tuning oscillator).
***Normally on blank pin (connected to F1 or FØ when tuning oscillator.

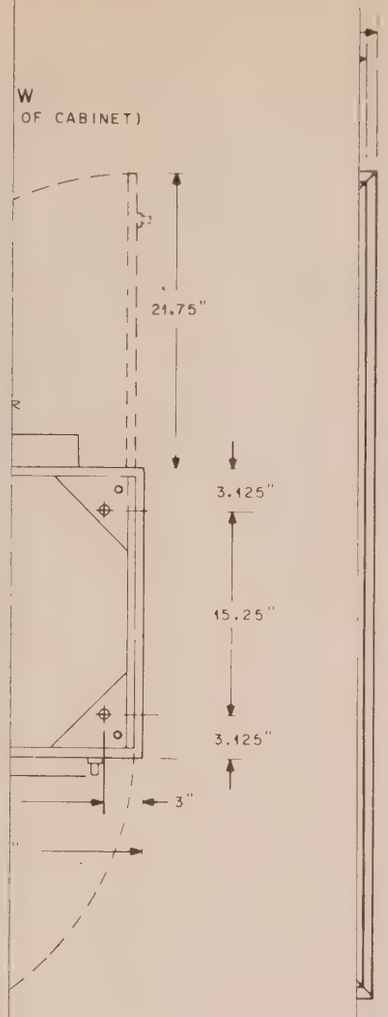
5.5.6 Receiver Quality Signal (RQS) Detector

JUMPER	JU1	JU2	JU3	JU4	JU5	JU6	JU7	JU8
STATUS	IN	OUT	IN	IN	IN*	IN*	IN*	IN*

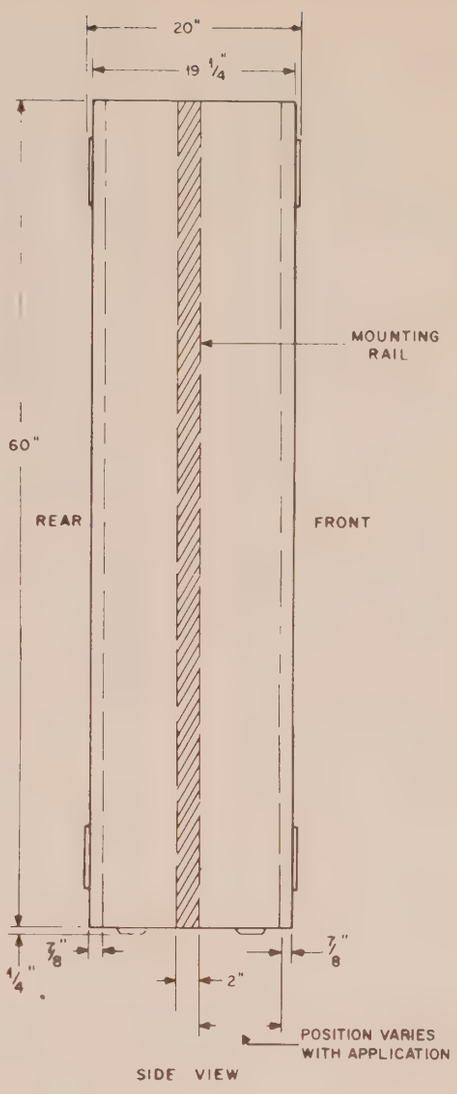
*Removed for tuning purposes.

5.5.7 Receiver Quality Signal (RQS, Line Current Generator)

JUMPER	STATUS
JU1	OUT
JU2	IN — 125 V DC OPERATION
	OUT — 60 V DC OPERATION
JU3	IN — 60 V DC OPERATION
	OUT — 125 V DC OPERATION
JU4	IN — SATELLITE RECEIVER APPLICATION
	OUT — BASE STATION APPLICATION
JU5, JU6	IN — BASE STATION APPLICATION
	OUT — SATELLITE RECEIVER APPLICATION
JU7	IN — TIE TRANSFORMER SHIELD TO GROUND
	OUT — NORMAL



CEPS-22346-O



SIDE VIEW

DESCRIPTION
PL-3626-O
SPEED NUT (4 req'd.) SCREW, tapping; 1/4 - 14 x 5/8" (4 req'd.)
PL-3402-O
SHIELD, rain (top) SHIELD, cover (top) COVER, rain shield SHIELD, rain (door) GASKET, rain shield GASKET, rain shield GASKET: 2 req'd. GASKET: 2 req'd. NUT, spring: No. 8; 4 req'd. SCREW, machine: 8-32 x 3/8"; 8 req'd. SCREW, tapping: 8-18 x 3/8"; 4 req'd. SCREW, tapping: 8-18 x 1/2"; 6 req'd.
PL-3401-A
CABINET (60-inch) DOOR VENT (8 required) SPEED NUT (48 required)

A = 22" CABINET WIDTH
B = 20-1/2" DOOR OPENING
C = 19-3/16" CABINET OPENING
D = 18-5/16" MTG. HOLE CENTERS
E = 17-11/16" CLEARANCE BETWEEN RAILS

CEPS-17187-B

Cabinet Dimensional Detail & Parts List
Motorola No. PEPS-28369-O
6/15/79-PHI

MOTOROLA INC.
Communications Group

SYSTEM AUDIO LEVEL ADJUSTMENTS

CONTENTS

Section *Page*

DESCRIPTION . . . 2
General . . . 2
Test Equipment Required . . . 2

GLOSSARY OF ABBREVIATIONS . . . 2

RECEIVER LEVELS (*MICOR* TONE AND DC CONTROL BASE STATIONS) . . . 2
RQS Module Level Set Adjustment (*Micor* DC Control Stations) . . . 2
Squelch Set (*Micor* DC Control Stations) . . . 2
Receiver Levels (Internal) . . . 3

***MICOR* TONE CONTROL BASE STATION TRANSMIT LINE LEVEL ADJUSTMENTS** . . . 3
PULSAR Terminal to Base Station Line Level Adjustments . . . 3
Equalization . . . 3
IDC Adjustment . . . 4
Transmitter Audio Level Adjustments . . . 4

RECEIVE LINE LEVEL ADJUSTMENTS . . . 4
Base Station to I/F Unit Line Levels . . . 4
Equalization . . . 4
Talk-Back-Tone Level Adjustment . . . 5
I/F Unit to *PULSAR* Terminal Level Adjustment . . . 5
Receiver Loop Current Adjustment . . . 5

***MOTRAC* DC CONTROLLED BASE STATION LINE LEVEL ADJUSTMENTS** . . . 5
I/F Unit to TRA Adapter Line Level Adjustments . . . 6
Equalization . . . 6
IDC Adjustment . . . 6
Transmitter Audio Level Adjustment . . . 6
Base Station to TRA Line Level Adjustment . . . 7
TRA to I/F Unit Line Level Adjustment . . . 7
Equalization . . . 7
Talk-Back-Tone Level Adjustment . . . 8
I/F Unit to *PULSAR* Terminal Line Level Adjustments . . . 8
Receiver Loop Current Adjustment . . . 8

***PULSAR* TERMINAL TO VOTING RECEIVERS AUDIO LINE LEVEL ADJUSTMENT** . . . 8
Equalization Adjustments . . . 9

***MICOR* DC CONTROLLED BASE STATION LEVEL ADJUSTMENTS** . . . 9
IDC Adjustment . . . 9
Transmitter Audio Level Adjustments . . . 9
Receiver Audio Level Adjustments . . . 9

technical writing services
1301 E. Algonquin Road, Schaumburg, Il. 60196

7/15/81-PHI

68P81060E24-O

1. GENERAL

1.1 System Audio Level Adjustments consist of audio line level and equalization adjustments between a *PULSAR* terminal and a tone controlled *Micor* or DC controlled *Motrac* base station. Line level adjustments are made for both the transmit and receive audio paths. Before making any adjustments all audio paths (phone line/carrier or microwave link) must be connected to the equipment.

1.2 TEST EQUIPMENT REQUIRED

The following test equipment is required for system line level adjustments:

- Two AC voltmeters Motorola Model S-1053C or equivalent
- One DC multimeter Motorola Model T1009A or equivalent
- One Motorola R1200A Series Service Monitor with RTC-4000A Deviation Meter and SLN6381A Audio Frequency Synthesizer, or equivalent
- One audio oscillator Motorola Model S1067B or equivalent.

In carrier systems, termination cards (part of the microwave link) should be used. The transmit termination card should be strapped for 15 dB, the receive termination card should be strapped for 7 dB. If termination cards are not used or are strapped differently, the line levels must be readjusted accordingly. Adjust all line levels to within ± .5 dB of the recommended levels.

2.2 GLOSSARY OF ABBREVIATIONS

- TRA — Tone Remote Adapter
- I/F — Tone Remote Control Interface Unit
- AQM — Audio Quality Module
- SUT (Set-Up-Tone) — A 1004 Hz tone sent from the *PULSAR* terminal at −4 dBm which will modulate the transmitter at ± 3 kHz deviation.

NOTE

Full system deviation is ±5 kHz. A 1004 Hz tone is recommended instead of 1000 Hz to avoid system problems where T2 carrier facilities are used.

3. RECEIVER LEVEL ADJUSTMENTS
(*Micor* Tone and DC Control Stations)

3.1 RQS MODULE LEVEL SET ADJUSTMENT
(*Micor* DC Control Stations)

The following procedure is for *Micor* IMTS base stations using dc control.

Step 1. Apply a 1000 uV carrier frequency signal to the antenna input of the receiver.

Step 2. Connect a voltmeter at pin 9 and pin 1 (ground) of the RQS detector module.

Step 3. Connect a milliammeter in series with the receiver line (TB1).

Step 4. Adjust the LEVEL SET 1 and LEVEL SET 2 potentiometers, on the RQS detector module, counterclockwise until a maximum output is indicated on the voltmeter.

Step 5. Adjust the LINE CURRENT ADJ potentiometer until 10.2 mA is obtained as a reading on the milliammeter.

Step 6. Reduce the quieting for 20 dBq (C-message weighted) on the receiver line.

Step 7. Set the DISABLE 1 switch to the right and adjust LEVEL SET 1 potentiometer for 7.3 mA on the line.

Step 8. Release DISABLE 1 and set DISABLE 2 to the right. Adjust LEVEL SET 2 potentiometer for 7.3 mA on the line.

Step 9. Release the DISABLE 2 switch.

Step 10. The final line current should be 7.6 mA. If it is not, repeat Steps 6 through 9 to yield 7.6 mA out as the final current.

Step 11. Remove the milliammeter and voltmeter from the receiver lines.

3.2 SQUELCH SET
(DC Control Station)

The squelch should be set for the system standard. If there is no standard, set the squelch for 12 dB of quieting. The following procedure is for setting the 12 dB level using the internal metering.

Step 1. On the station Metering Module, set the following switches:

- LINE/SPKR LOAD switch to the SPKR LOAD position.
- SPKR/SPKR LOAD switch to the SPKR LOAD position
- AUDIO LEVEL selector switch to the 0 dB position.
- FUNCTION switch to SPKR-LINE position.

Step 2. Adjust the volume control for a 0 dB reading, with no rf signal applied.

Step 3. Apply an unmodulated carrier frequency signal to the antenna input of the receiver.

Step 4. Adjust the rf signal strength until the meter reading (across the speaker load) drops 12 dB. This is 12 dBq.

Step 5. Adjust the squelch control to a point where the receiver just squelches.

Step 6. Remove the test equipment. Make sure that the selector switch on the Metering Module is in the off position.

3.3 RECEIVER LEVELS (INTERNAL)

Potentiometer R203 (located on the audio and squelch board) is factory set and should not require adjustment. However, if a problem is noted which can be traced to the audio and squelch board the following procedure should be tried before further troubleshooting.

Step 1. Apply a 1000 uV on-channel signal to the receiver.

Step 2. Modulate the generator at ±3 kHz deviation with a 1004 Hz tone.

Step 3. Connect voltmeter to pins 1 and 7 of the receiver audio board.

Step 4. Adjust the audio control potentiometer (R203) for a level of 150 mV.

Step 5. Remove test equipment.

NOTE

For installation and adjustment of the optional TLN5948A Sub-Audible Paging module, refer to section 68P81041E47 in the module segment of this manual.

4. *MICOR* TONE CONTROL BASE STATION TRANSMIT LINE LEVEL ADJUSTMENTS

4.1 *PULSAR* TERMINAL TO BASE STATION LINE LEVELS

Adjust terminal to base station line levels as follows:

Step 1. Connect an ac voltmeter to the BRIDGE jack of the Interface (I/F) unit line driver. (In transmitter steering units use line driver No. 1.)

Step 2. Disable the *PULSAR* terminal audio by plugging a quiet termination into the interface jack on the control module.

Step 3. Enable the line driver by holding the control module transmit switch to the right.

Step 4. Adjust the I/F unit line driver OUTPUT LEVEL potentiometer for a meter reading of −40 dBm. Remove the quiet termination.

Step 5. Apply a 1004 Hz tone, from an audio oscillator to the send jack on the *PULSAR* terminal test panel.

Step 6. Connect an (unterminated and ungrounded) ac voltmeter to the third multiple jack on the test panel.

Step 7. Adjust the oscillator output for a meter reading of −4 dBm on the transmit line.

Step 8. Adjust the AUDIO LEVEL control (on the I/F unit control module) for a meter reading of −14 dBm at the BRIDGE jack of the I/F unit line driver. (In transmitter steering systems, set each line driver OUTPUT LEVEL control for −14 dBm.)

Step 9. Release the transmit switch on the control module.

Step 10. Disconnect the oscillator and ac voltmeter.

4.2 EQUALIZATION

If equalization is not required the following procedure may be shipped. If equalization is required, establish a communications link between the I/F and base station, and proceed as follows:

Step 1. Connect an audio oscillator adjusted to 1004 Hz to the control module INTERFACE jack.

Step 2. Connect ac voltmeter to the BRIDGE jack of the I/F line driver and to the transmitter BRIDGE jack of the base station line driver.

Step 3. Hold the control module transmit switch to the right.

Step 4. Adjust the audio oscillator level for a meter reading of −14 dBm at I/F line driver BRIDGE jack.

Step 5. Measure and record the meter reading at the base station line driver.

Step 6. Change the audio oscillator frequency to 400 Hz (with the same output level).

Step 7. Find the difference (in dB) between the 1004 Hz and 400 Hz tone, at the base station.

Step 8. Move the VIO-WHT jumper on the I/F line driver to the left-most number that is closest to the difference obtained in Step 7. For example: if the 400 Hz tone is 4 dB lower than the 1000 Hz tone, move the jumper to the 3 dB position.

Step 9. Change the audio oscillator frequency to 2700 Hz (with the same output level).

Step 10. Find the difference (in dB) between the 2700 Hz and 1004 Hz tones.

Step 11. Move the BLU-WHT jumper on the I/F unit line driver to the right-most number closest to the difference obtained in Step 10.

Step 12. Repeat Steps 1-11.

Step 13. If either or both jumpers were re-positioned, repeat Steps 1-10 of paragraph 4.1.

Step 14. Disconnect the audio oscillator and ac voltmeter.

4.3 IDC ADJUSTMENT

IDC adjustment — use the following procedure to adjust the transmitter IDC control.

Step 1. Insert a quiet termination into the INTERFACE jack on the control module.

Step 2. Apply a 1004 Hz 1 V rms tone into the XCTR LEVEL jack on the base station line driver module.

Step 3. Key the transmitter by moving the base station control module LOCAL ENABLED, and F1 ENABLED switches to the right.

Step 4. Check transmitter for 5 kHz deviation.

Step 5. If transmitter deviation is not ±5 kHz adjust the exciter IDC control (R410) to produce ±5 kHz deviation.

Step 6. Return the LOCAL ENABLED and F1 ENABLED switches to the normal position, remove the quiet termination from the control module INTERFACE jack, and disconnect the tone from the line driver.

4.4 TRANSMITTER AUDIO LEVEL ADJUSTMENTS

Use the following procedure to adjust transmitter audio levels.

Step 1. Apply a 1004 Hz tone to the SEND jack on the *PULSAR* terminal. Adjust the oscillator for −4 dBm on the *PULSAR* terminal transmit lines.

Step 2. Connect an ac voltmeter to the XMTR BRIDGE jack on the base station line driver.

Step 3. Hold the transmit switch on the control module to the right. The ac voltmeter connected to the XMTR BRIDGE jack should read between 0 and −24 dBm (system loss included).

Step 4. Adjust the base station line driver XCTR LEVEL control for a transmitter deviation of 3 kHz.

Step 5. Release the TRANSMIT switch on the control module.

Step 6. Repeat equalization, IDC and transmitter audio level adjustments for each station site.

5. RECEIVE LINE LEVEL ADJUSTMENTS

5.1 BASE STATION TO I/F UNIT LINE LEVELS

Audio line levels between a base station and I/F unit are adjusted as follows.

Step 1. Apply an on-channel rf signal modulated ±3 kHz by a 1004 Hz tone to the base station receiver.

Step 2. Connect an ac voltmeter to the RCVR BRIDGE jack of the base station line driver and the BRIDGE jack of the associated AQM.

Step 3. Adjust the OUTPUT LEVEL control on the line driver for a meter reading of −14 dBm at the line driver RCVR BRIDGE jack.

Step 4. Measure and record the meter reading at the AQM module BRIDGE jack (indicates loss).

Step 5. Disconnect the rf signal. (Receiver should be squelched).

CAUTION

Turn power off before removing or re-inserting modules.

Step 6. Remove the encoder module, attach an extender card, and re-insert the module.

Step 7. Adjust the encoder module tone level control until the meter reading at the AQM module BRIDGE jack is 9 dB below the level measured in Step 4.

5.2 EQUALIZATION

The purpose of the line equalization procedure is to improve the frequency response between the base station and interface sites. Two technicians are required to perform the line equalization procedure; one at the base station site and the other at the interface site. The technician at the base station site measures the line level at the output of the receiver while the technician at the interface site measures the line level at the input to the interface. Voice communications between the operators is necessary in order to implement this procedure. If intercom is chosen over other methods of voice communications, a handset is required at both units. Line Equalization is performed by setting the 1004 Hz test tone (used in the line level adjustment procedure) equal to the LOW and HIGH test tone levels generated by the encoder module.

NOTE

Consult the installation section of the *PULSAR* Tone Remote Control Interface Unit manual (68P81033E25) for interface intercom operation.

To check the base station receiver lines, complete Steps 1-7 in the receive line adjustments paragraph. The line driver module must be installed in the card extender in order to complete the following procedure.

Step 1. Measure and record the status tone level at the RCVR BRIDGE jack of the line driver.

Step 2. Apply a 1 mV on-channel rf signal to the receiver antenna input.

Step 3. Modulate the rf signal with a 1004 Hz tone until the level measured at the BRIDGE jack is the same as the status tone level measured in Step 1.

Step 4. Measure and record the level of this signal at the BRIDGE jack of the AQM module.

Step 5. Disconnect the rf signal to the receiver.

Step 6. Hold the HIGH TONE switch on the encoder module to the right. Measure and record the level at the AQM module (in the I/F unit) BRIDGE jack.

Step 7. Release the HIGH TONE switch and repeat Step 6 for the LOW TONE switch.

Step 8. Re-position the 2500 Hz jumper (in series with L2 on the line driver) to the 3, 6, or 9 dB position until the high tone and the 1004 Hz tone levels are as close as possible in amplitude.

Step 9. Re-position the 400 Hz jumper (in series with L1) to the 3, 6, or 9 dB position until the low tone level is as close as possible to the 1004 Hz tone level.

Step 10. Repeat equalization procedure.

Step 11. If it is necessary to move either or both of the jumpers, repeat Steps 1-7 of paragraph 5.1.

Step 12. Remove the card extender and reinsert the module.

5.3 TALK-BACK-TONE LEVEL ADJUSTMENT

Step 1. Remove tone function decoder module from chassis.

Step 2. On the tone function module, connect JU6 to the CON (continuous) position.

Step 3. Attach the card extender to the module, and reinsert the module into the chassis.

Step 4. Apply a 1 mV on-channel (unmodulated) rf signal to the base station receiver.

Step 5. On the tone function board, adjust potentiometer R29 until the level measured at the BRIDGE jack of the AQM module is 12 dB below the level measured in Step 4 of paragraph 5.1 (receiver line level adjustments).

Step 6. Remove the tone function decoder module, reconnect JU6 to the ST position, remove the card extender, and reinsert the module into the chassis.

Step 7. Disconnect all test equipment.

5.4 I/F UNIT TO *PULSAR* TERMINAL LEVEL ADJUSTMENTS

Step 1. Apply an on-channel rf signal, modulated at ± 3 kHz deviation with a 1004 Hz tone.

Step 2. Connect an ac voltmeter to the BRIDGE jack of the audio select driver module of the *PULSAR* I/F unit.

Step 3. Adjust OUTPUT LEVEL control on the audio select driver module for a meter reading of − 8 dBm at the BRIDGE jack.

Step 4. Refer to the *PULSAR* terminal level setting procedure, and adjust the receiver level control (R8 on the RIU card).

NOTE

The *PULSAR* terminal level setting procedure is located behind the System Installation tab in the *PULSAR* Fully Automatic Control Terminal instruction manual 68P81028E65.

Step 5. Disconnect the rf input to the base station, and the ac voltmeter from the audio select module.

5.5 RECEIVER LOOP CURRENT ADJUSTMENT

Receiver loop current is factory adjusted and should not normally need to be re-adjusted.

For loop current testing and adjustment procedures, refer to the Current Generator Check paragraph in the Installation section of *PULSAR* Tone Remote Control instruction manual 68P81033E25.

6. *MOTRAC* DC CONTROL BASE STATION LINE LEVEL ADJUSTMENTS

NOTE

The Tone Remote Adapter is located with the base station.

6.1 I/F UNIT TO TRA LINE LEVEL ADJUSTMENTS

I/F unit to Tone Remote Adapter (TRA) line levels are adjusted as follows.

Step 1. Connect an ac voltmeter to the BRIDGE jack of the I/F unit line driver.

Step 2. Plug a quiet termination into the INTERFACE jack on the control module.

Step 3. Hold the TRANSMIT switch on the line driver to the right.

Step 4. Adjust the OUTPUT LEVEL control on the line driver for a meter reading of −40 dBm (low level pilot tone). Remove the quiet termination.

Step 5. Apply a 1004 Hz tone, from an audio oscillator to the send jack on the *PULSAR* terminal.

Step 6. Connect an (unterminated and ungrounded) ac voltmeter to the third multiple jack on the test panel.

Step 7. Adjust the oscillator output for a meter reading of −4 dBm on the transmitter line.

Step 8. Adjust the AUDIO LEVEL control [on the interface (I/F) unit control module] for a meter reading of −14 dBm at the BRIDGE jack of the (I/F unit) line driver. (In transmitter steering systems set each line driver OUTPUT LEVEL control for −14 dBm.)

Step 9. Release the transmit switch on the control module.

Step 10. Disconnect the oscillator and ac voltmeters.

6.2 EQUALIZATION

If equalization is not required the following procedure may be skipped. If equalization is required, establish a communications link between the two sites and proceed as follows.

Step 1. Connect an audio oscillator adjusted to 1004 Hz to the control module INTERFACE jack.

Step 2. Connect an ac voltmeter to the BRIDGE jack of the I/F unit line driver, and to the bottom BRIDGE jack of the TRA No. 1 line driver.

Step 3. Adjust the oscillator level for a meter reading of −14 dBm at the I/F unit line driver.

Step 4. Record the meter reading at the TRA No. 1 line driver.

Step 5. Change the oscillator frequency to 400 Hz (with the same output level).

Step 6. Record the meter reading at the TRA line driver.

Step 7. Find the (dB) difference in levels between the 1004 Hz and the 400 Hz tones.

Step 8. Move the VIO-WHT jumper on the I/F unit line driver to the left-most number that is closest to the difference obtained in Step 6.

Step 9. Change the oscillator frequency to 2.7 kHz, and record the level of this tone at the TRA unit.

Step 10. Find the (dB) difference in level between 2.7 kHz and 1004 Hz.

Step 11. Move the BLU-WHT on the I/F line driver to the right-most number that is closest to the difference obtained in Step 9.

NOTE

This procedure should be performed twice; after the first time, repeat Steps 1-11.

Step 12. If it was necesary to move either of the jumpers repeat Steps 1-10 of the I/F unit to TRA Line Level Adjustments procedure.

6.3 IDC ADJUSTMENT

Adjust the transmitter for maximum allowable deviation (5 kHz) with specified audio levels. Use the following procedure to adjust the IDC control.

Step 1. Insert a quiet termination into the INTERFACE jack on the control module.

Step 2. Apply a 1004 Hz 1 V rms tone into the XCTR LEVEL jack on the base station line driver module.

Step 3. Key the transmitter by moving the base station control module LOCAL ENABLED, and F1 ENABLED switches to the right.

Step 4. Check transmitter for ±5 kHz deviation.

Step 5. If transmitter deviation is not ±5 kHz adjust the exciter IDC control (R410) for ±5 kHz deviation.

Step 6. Return the LOCAL ENABLED and F1 ENABLED switches to the normal position, remove quiet termination from control module INTERFACE JACK, and disconnect the tone from the line driver.

6.4 TRANSMITTER AUDIO LEVEL ADJUSTMENT

Step 1. Apply a 1004 Hz tone to the SEND jack on the *PULSAR* terminal, and adjust oscillator for −4 dBm on the *PULSAR* terminal transmit lines.

Step 2. Connect an ac voltmeter to the bottom BRIDGE jack on the position No. 1 line driver (TRA) of the I/F unit.

Step 3. Hold the TRANSMIT switch on the I/F unit control module to the right. The ac voltmeter should read between 0 and −24 dBm. This level includes the facility loss.

Step 4. Remove the ac voltmeter from the BRIDGE jack and connect it between pins 1 and 24 of the position No. 1 line driver.

Step 5. Adjust the line driver INPUT LEVEL control for a meter reading of −18 dBm.

Step 6. Adjust the position No. 5 line driver OUTPUT LEVEL control, for 3 kHz transmitter deviation.

Step 7. Release the transmit switch on the control module, remove the 1004 Hz tone, and disconnect the ac voltmeter.

6.5 BASE STATION-TO-TRA LINE LEVEL ADJUSTMENTS

Step 1. Set the position No. 5 line driver (in the TRA) INPUT LEVEL control fully counterclockwise.

Step 2. Set all switches on the base station control module to the left.

Step 3. Set both equalization jumpers on the line driver modules to the 0 dB position.

Step 4. Connect a 0-10 mA milliammeter in series with one side of the audio line connected between the base station and the TRA "0" terminals.

Step 5. Adjust the receiver SQUELCH control to unsquelch the receiver. (In normal system operation, the station is left unsquelched).

Step 6. Measure and record the average value of the residual receiver quality signal (RQS) current sent by the base station when no signal is present (0 dB quieting).

Step 7. Apply an unmodulated on-channel rf carrier to the base station receiver and adjust the signal level for a meter reading of 1 mA above the level measured in Step 6.

Step 8. Connect a dc voltmeter between pin 5 and ground on the logic module.

Step 9. Adjust the TRIP PT ADJ control on the logic module until the voltage at pin 5 goes high (approximately A + level).

Step 10. Remove the milliammeter and reconnect the audio lines.

Step 11. Apply an on-channel rf signal modulation at ±3 kHz deviation with a 1004 Hz tone to the base station receiver.

Step 12. Connect an ac voltmeter between pins No. 1 and 24 of the base station (pos 5) line driver.

Step 13. Adjust the line driver (pos 5) INPUT LEVEL control for a meter reading of −18 dBm.

Step 14. Plug an ac voltmeter into the top BRIDGE jack of the position 1 line driver.

Step 15. Adjust the position 1 line driver OUTPUT LEVEL control for a meter reading of −14 dBm.

Step 16. Disconnect the ac voltmeters.

6.6 TRA TO I/F UNIT LINE LEVEL ADJUSTMENTS

TRA to I/F unit line levels are adjusted as follows.

Step 1. Connect an ac voltmeter to the BRIDGE jack of the associated AQM module.

Step 2. Measure and record the meter reading at the AQM module (reading includes facility loss).

Step 3. Disconnect the rf signal to the receiver (receiver should be squelched).

Step 4. Remove encoder module, attach a card extender, and re-insert encoder module.

Step 5. Adjust the encoder module tone level control for a meter reading 9 dB below the level measured in Step 2.

6.7 EQUALIZATION

Use the following procedure to make equalization adjustments between the TRA adapter and I/F unit. Before performing the equalization adjustment, establish communications between the two sites.

Step 1. Measure and record the status tone level at the top BRIDGE jack of the position 1 line driver.

Step 2. Apply a 1 mV on-channel rf signal to the receiver antenna input.

Step 3. Modulate the rf signal with a 1004 Hz tone until the level measured at the BRIDGE jack is the same as the status tone level measured in Step 1.

Step 4. Measure and record the level of this signal at the BRIDGE jack of the AQM module.

Step 5. Disconnect the rf signal to the receiver.

Step 6. Hold the HIGH TONE switch on the encoder module to the right. Measure and record the level at the AQM module (in the I/F unit) BRIDGE jack.

Step 7. Release the HIGH TONE switch and repeat Step 6 for the LOW TONE switch.

Step 8. Re-position the 2500 Hz jumper (in series with L2 on the position 1 line driver) to the 3, 6, or 9 dB position until the high tone and the 1004 Hz tone levels are as close as possible in amplitude.

Step 9. Re-position the 400 Hz jumper (in series with L1) to the 3, 6, or 9 dB position until the low tone level is as close as possible to the 1004 Hz tone level.

Step 10. Repeat equalization procedure.

Step 11. If it is necessary to move either or both of the jumpers, repeat Steps 11 through 15 of section 6.5, and repeat section 6.6.

Step 12. Remove the card extender and reinsert the module.

6.8 TALK-BACK-TONE LEVEL ADJUSTMENT

Step 1. Remove tone function decoder module from chassis.

Step 2. On the tone function module, connect JU6 to the CON (continuous) position.

Step 3. Attach the card extender to the module, and reinsert the module into the chassis.

Step 4. Apply a 1 mV on-channel rf signal (unmodulated) to the base station receiver.

Step 5. On the tone function board, adjust potentiometer R29 until the level measured at the BRIDGE jack of the AQM module is 12 dB below the level measured in Step 2 of section 6.6.

Step 6. Remove the tone function decoder module, reconnect JU6 to the ST position, remove the card extender, and reinsert the module into the chassis.

Step 7. Disconnect all test equipment.

6.9 I/F UNIT TO *PULSAR* TERMINAL LINE LEVEL ADJUSTMENTS

I/F unit to *PULSAR* terminal line level adjustments are made using the following procedure.

Step 1. Apply an on-channel rf signal, modulated 3 kHz by a 1004 Hz tone.

Step 2. Connect an ac voltmeter to the BRIDGE jack of the audio select driver module of the *PULSAR* I/F unit.

Step 3. Adjust OUTPUT LEVEL control on the audio select driver mdoule for −8 dBm on the ac voltmeter connected to the BRIDGE jack.

Step 4. Refer to the *PULSAR* terminal level setting procedure, and adjust the receiver level control (R8) on the RIU card.

NOTE

The *PULSAR* terminal level setting procedure is located behind the System Installation tab in the *PULSAR* Fully Automatic Control Terminal instruction manual 68P81028E65.

Step 5. Disconnect the rf input to the base station, and the ac voltmeter from the audio select module.

6.10 RECEIVER LOOP CURRENT ADJUSTMENT

Receiver loop current is factory adjusted and should not normally need to be re-adjusted. For loop current testing and adjustment procedures, refer to the Current Generator Check paragraph in the Installation section of *PULSAR* Tone Remote Control Instruction Manual 68P81033E25.

7. *PULSAR* TERMINAL TO VOTING RECEIVERS AUDIO LINE LEVEL ADJUSTMENT

Adjust audio levels between *PULSAR* terminals and voting receivers as follows.

Step 1. Apply a 1 mV on-channel rf signal modulated at ±3 kHz deviation with a 1004 Hz tone.

Step 2. Connect an ac voltmeter to the BRIDGE jack of the audio control module, and to the BRIDGE jack of the associated AQM module (located in the *Spectra-TAC* receiver).

Step 3. Adjust the audio control module LINE LEVEL control for a reading of −14 dBm on the ac voltmeter connected to the BRIDGE jack of the audio control module.

Step 4. Measure and record the level on the ac voltmeter connected to the BRIDGE jack of the AQM module. (This level includes the facility loss between the *PULSAR* terminal and voting receivers.)

Step 5. Disconnect the rf signal to the receiver (receiver should be squelched).

CAUTION

Turn power off before removing or inserting modules.

Step 6. Remove the encoder module, attach a card extender, and re-insert the module.

Step 7. Adjust the tone level control on the encoder module until the level measured at the BRIDGE jack of the AQM module is 9 dB below the level measured in Step 4.

7.1 EQUALIZATION ADJUSTMENTS
(If equalization is not required, omit this procedure.)

Step 1. Measure and record the status tone level at the BRIDGE jack of the audio control module.

Step 2. Apply a 1 mV on-channel rf signal modulated by a 1004 Hz tone.

Step 3. Adjust the deviation until the level measured at the BRIDGE jack of the audio control module is the same as the status tone level measured in Step 1.

Step 4. Measure and record the signal level at the BRIDGE jack of the AQM module.

Step 5. Disconnect the rf input to the receiver.

Step 6. Hold the HIGH TONE switch on the encoder module to the right.

Step 7. Measure and record the high tone level at the AQM module BRIDGE jack.

Step 8. Release the HIGH TONE switch, and repeat Steps 6 and 7 using the LOW TONE switch.

Step 9. Re-position the 2500 Hz jumper on the audio control module so that the high tone and the 1004 Hz tone levels are as close as possible.

Step 10. Re-position the 400 Hz jumper so that the low tone and the 1004 Hz tone levels are as close as possible.

Step 11. Repeat equalization adjustment.

Step 12. If either or both of the jumpers was repositioned, repeat Steps 1-7 of paragraph 7.

Step 13. Perform the line level and equalization adjustment procedures for each voting receiver.

8. *MICOR* DC CONTROLLED BASE STATION TRANSMITTER LINE LEVEL ADJUSTMENTS

8.1 IDC ADJUSTMENT

Use the following procedure to adjust the transmitter IDC control.

Step 1. Insert a quiet termination into the XMTR STA jack on the line driver module.

Step 2. Apply a 1004 Hz, 1 V rms tone into the XCTR LEVEL jack on the base station line driver module.

Step 3. Key the transmitter by moving the base station control module LOCAL ENABLED, and F1 ENABLED switches to the right.

Step 4. Check transmitter for ±5 kHz deviation.

Step 5. If transmitter deviation is not ±5 kHz, adjust the exciter IDC control (R410) for ±5 kHz deviation.

Step 6. Return the LOCAL ENABLED and F1 ENABLED switches to the normal position. Remove the quiet termination and disconnect the tone from the line driver.

8.2 TRANSMITTER AUDIO LEVEL ADJUSTMENT

Step 1. Apply a 1004 Hz −4 dBm tone to the transmit line from the *PULSAR* terminal (terminal should be in the F1 mode).

Step 2. Connect an ac voltmeter to the XMTR BRIDGE jack on the base station line driver module.

Step 3. The voltmeter should read between 0 and −24 dBm (system loss included).

Step 4. Adjust the base station line driver XCTR level control for a transmitter deviation of ±3 kHz.

Step 5. Remove the tone and the ac voltmeter.

8.3 RECEIVER AUDIO LEVEL ADJUSTMENT

Step 1. Apply an on-channel rf signal modulated with 3 kHz deviation by a 1004 Hz tone to the base station receiver.

Step 2. Connect an ac voltmeter to the RCVR BRIDGE jack of the base station line driver.

Step 3. Adjust the OUTPUT LEVEL control on the line driver for a meter reading of −7 dBm.

Step 4. Refer to the *PULSAR* terminal level setting procedure and adjust the receiver level control (R8 on the RIU card).

NOTE

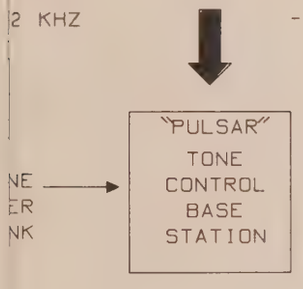
The *PULSAR* terminal level setting procedure is located behind the System Installation tab in the *PULSAR* Fully Automatic Control Terminal instruction manual 68P81028E65.

INPUT LEVEL FOR 3KHZ DEVIATION
(FOR TONE CONTROL BASE STATION
OR TONE REMOTE ADAPTER)
PHONE LINE/CARRIER

TONE	INPUT LEVEL
1004 HZ	-24 DBM
2 KHZ	-27 DBM

MICROWAVE LINK

TONE	INPUT LEVEL
1004 HZ	-13 DBM
2 KHZ	-16 DBM



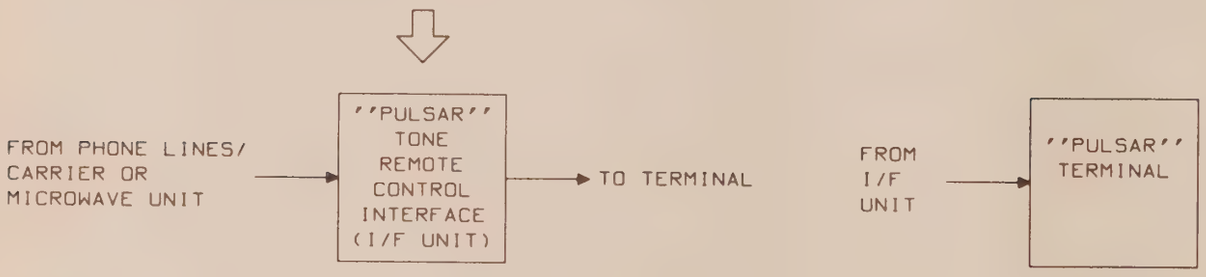
ER INPUT — 1004HZ _____ DBM
ON OR TRA — 2KHZ _____ DBM

NK INPUT — 1004HZ _____ DBM
ON OR TRA — 2KHZ _____ DBM

Transmit Path Block Diagram
*Motorola No. **EEPS-32366-O***
7/15/81-PHI

OUTPUT

(PHONE LINES/CARRIER 16DB GAIN INTO TERMINAL)
(MICROWAVE LINK 5DB GAIN INTO TERMINAL



INPUT LEVELS TO I/F

1004HZ _____ DBM

2375HZ _____ DBM

INPUT LEVEL TO TERMINAL

1004HZ _____ DBM

PP/EPS-32367-0

.. INTRODUCTION

This section of the manual describes local operation echniques required to perform maintenance checks. Overall station maintenance is detailed in this section while specific chassis maintenance (transmitter, and eceiver) is provided in the following paragraphs.

:. LOCAL OPERATION FOR TESTING AND MAINTENANCE

Once power is applied and the station is properly djusted, this base station is normally operated entirely inattended from a remote control point. However, the tation may be locally operated utilizing controls on ontrol modules in the unified chassis. This type of peration may be necessary to accomplish station naintenance and testing.

Local operation of the station is primarily ac- omplished utilizing controls on the station control nodule located in the unified chassis. The controls and unctions are listed in Table 1.

WARNING

The transmitter can be keyed remotely. To prevent unexpected transmitter keying while servicing the station, be sure the LOCAL ENABLE switch is actuated (direction of arrow).

The following are procedures pertaining to the local operation of a remotely controlled station.

2.1 TRANSMITTER CONTROL

To prevent the transmitter from being keyed remotely, set station control module LOCAL ENABLE switch in the direction of the arrow. At conclusion of local operation, insure that the LOCAL ENABLE switch is returned to its normal position (opposite direction of the arrow).

2.2 HANDSET

Connect a handset to the HANDSET receptacle on the line driver module.

Table 1. Station Control Module Switch Functions

Switch	Position	Functions Possible
	Normal (left)	Normal mode of operation.
F1**	Actuated (right)	Transmission in F1 mode enabled when station is keyed locally.
FØ **	Normal (left)	Normal mode of operation.
	Actuated (right)	Transmission in FØ mode enabled when station is keyed locally.
LOCAL ENABLE*	Normal (left)	Transmitter can be operated by remote control.
	Actuated (right)	Transmitter can *not* be operated by remote control.

*The LINE DISABLE LED is illuminated when the LOCAL ENABLE switch is actuated.
**The F1 or FØ LED is illuminated when the associated mode is activated.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

2.3 LOCAL SPEAKER

Place the SPEAKER MONITOR switch on the station line driver module in the RCVR position. Set the function switch on the metering module to the SPKR/LINE position.

2.4 SELECTION OF OTHER MODES

All other functions that can be activated by remote control can also be activated locally. The station control module has test switches to activate these functions, such as F1.

2.5 RECEIVED AUDIO

After the local speaker is turned on, the station is ready to receive audio. If necessary, the receiver can be unsquelched utilizing the receiver SQUELCH control on the receiver chassis. The VOLUME control on the receiver chassis sets the audio output level of the local speaker.

2.6 TRANSMITTING

NOTE

Before initiating any local transmissions, monitor the channel to ensure that it is clear of other transmissions.

The transmitter is locally keyed by activating the push-to-talk handset switch. Voice is transmitted using the local handset.

2.7 CONCLUDING LOCAL OPERATION

At the conclusion of local operation, perform the following operations and checks to ensure that the station is ready for remote operation.

Step 1. Reset receiver squelch level per procedures in the Installation Section (Squelch Set) of this manual.

Step 2. Ensure that station control module switches are positioned for normal operation (see Table 1).

Step 3. Disconnect handset.

Step 4. Set all external power switches ON.

Step 5. Ensure that station is operable from remote location.

Step 6. Turn local speaker OFF (if applicable).

Step 7. Disconnect or remove any metering plugs or test set.

Step 8. Ensure that cabinet doors are locked.

Step 9. Ensure that vents in cabinet are unobstructed.

3. MAINTENANCE TECHNIQUES

3.1 GENERAL

Maintenance procedures for individual chassis, which comprise this station, are contained in the following sections of this manual. As an aid to isolating a malfunction to a specific chassis or module, a variety of techniques are appropriate.

NOTE

Some adjustments require the use of a card extender. Care should be taken when using the card extender to prevent damage to the module or injury to the technician. When removing the extender from the chassis, use a rocking motion.

3.2 TRANSMITTER AND RECEIVER

Most troubles in the transmitter or receiver can be quickly isolated with metering checks. A log of normal meter readings for this station should be maintained. Each time maintenance is performed, the meter readings should be entered into the log. Variations from the previous readings can help to isolate a malfunction or may indicate an impending failure. If no previous meter readings are available, typical or minimum meter readings may be found with the receiver rf & i-f, exciter, power amplifier or power control board maintenance sections, as well as metering procedures.

3.3 POWER SUPPLY

A check of power supply voltages under load and no-load conditions (transmit and standby) should quickly isolate any malfunction.

3.4 REMOTE CONTROL UNIT

Isolation of a malfunction in the control portion of the unified chassis requires a functional understanding of the overall station operation and the interrelationship between the various modules and chassis of the station. The Functional Description section under the Station Data Tab provides necessary information. With a basic understanding of station operation, troubles may be isolated by analyzing the following questions:

(1) Can the station be operated locally but not remotely? If so, this eliminates many circuits as possible sources of trouble.

(2) How many modes are inoperable? Concentrate testing on circuits that are common to the inoperable modes.

(3) Are adjustments properly set? This includes audio level adjustments at the station and at the remote control point.

4) Are jumpers properly installed? The many jumpers in this equipment provides vast flexibility, but could be a source of trouble if improperly added, removed, or not removed, as the case may be.

4. ROUTINE MAINTENANCE CHECK LIST

A check list for the performance of routine maintenance is given in Table 2.

Table 2. Routine Maintenance Check List

ITEM	CHECK
Receiver	Measure the signal level required to obtain 20 dB quieting.
	Compare meter readings with the minimum value and all previous readings taken. Realign the receiver, if necessary.
Transmitter	Measure transmitter output power.
	Compare meter readings with the minimum value and all previous readings taken. Realign the transmitter, if necessary.
	Verify that the transmitter is on frequency and adjust if necessary.
	Tune and load the transmitter to the antenna.
	Measure transmitter frequency deviation for voice modulation. Adjust the "IDC" control, if necessary.
	Measure the exciter modulator sensitivity.
System Operation	Measure and adjust the audio input to the exciter.
	Measure and adjust the receiver(s) audio output to the control line.
	Check control line levels and functions for proper operation.
	Adjust receiver(s) on frequency with the distant transmitter(s) in the system.
	Check all accessory equipment for proper operation.
After Performing Maintenance	Check all items listed in the Concluding Local Operation paragraph of this section of the instruction manual.

5. TABLE OF RECOMMENDED TEST EQUIPMENT

A list of recommended test equipment for maintenance of this equipment is given in Table 3.

Table 3. Recommended Test Equipment

Type of Equipment or Type of Measurement	Equipment Characteristics	Recommended Type
Transmitter Frequency Measurement	Frequency -- 150-160 MHz Accuracy -- ± .00005% or better	Any of the following items of Motorola Test Equipment: Model R1200A Service Monitor Model S1344A Frequency Counter & Deviation Meter Model S1343A Frequency Counter
Transmitter Deviation Measurement	Peak reading type for voice or sinusoidal wave; scales for accurate reading of ± 5 kHz deviation	Any of the following items of Motorola Test Equipment: Model R1200A Service Monitor Model S1344 Frequency Counter & Deviation Meter Model R1007A Series Auto-Tune Deviation Meter
Transmitter Power Output Measurement	150-160 MHz; 50 ohms; at least 0-150 watts. 50 ohm dummy load; at least 150 watts	Motorola S1350A Wattmeter with appropriate element Motorola Model S1013A RF Load Resistor

Table 3. Recommended Test Equipment (Cont'd.)

Type of Equipment or Type of Measurement	Equipment Characteristics	Recommended Type
RF Signal Generator for receiver testing	150-160 MHz; FM; high-stability (± .0002% or better); adjustable output 0 to 1000 microvolts	Motorola Model R1200A Service Monitor Motorola Model R1201A Series AM-FM Signal Generator
Audio Voltage Measurements	High impedance (10 megohm); dBm scale	Motorola Model S1053D Solid State AC voltmeter
Audio Signal Generator for audio circuit testing in receiver and transmitter	Variable amplitude 0 to 1 volt; 1000 Hz tone (300 to 3000 Hz preferred); sinusoidal wave C-Message Weighted	Motorola Model S1067B Solid State Audio Oscillator Motorola Model TEK1B Tone Oscillator Motorola Model R1200A Series Service Monitor
DC Voltage Measurements, Resistance Measurements, RF Voltage Measurements	High impedance (11 megohm) DC multimeter	Motorola S1063B Solid State DC Multimeter with SLN6055A RF Probe Motorola Model R1001 Digital Multimeter
Waveform Measurements	Oscilloscope: Audio Circuit Measurements RF Circuit Measurements at least 50 MHz bandwidth	A very high quality instrument is required.
Tuning Tool	Used for adjusting all tunable components during equipment alignment.	Motorola Part No. 66A84387C01
Contact Removal Tool	Used to remove female wire terminals from metering cable connector	Motorola Part No. 66B84690C01

STATION DATA

Description 68P81041E74
Installation 68P81042E41
System Audio Level Adjustments 68P81060E24
Station Maintenance 68P81042E51

TRANSMITTER

Transmitter Introduction 68P81042E88
Transmitter Interconnect Board 68P81041E44
Exciter 68P81026E66
Power Amplifier 68P81039E38
Power Control Board 68P81015E07

RECEIVER

Receiver Introduction 68P81042E89
Receiver Interconnect Board 68P81034E07
RF & I-F Board 68P81026E37
Audio & Squelch Board 68P81025E79
Audio & Power Amplifier 68P81014E97

POWER SUPPLIES

Power Supply 68P81020E44
Power Supply 68P81041E49

MISCELLANEOUS

RF Wattmeter 68P81041E76
F0 Kit 68P81042E12
Power Coupler 68P81042E11

REMOTE CHASSIS AND MODULES

Remote Control Chassis 68P81041E51
Line Driver 68P81041E48
Station Control 68P81041E39
Pilot Tone Decoder 68P81041E41
Tone Function Decoder 68P81041E42
Encoder 68P81036E36
DC Function Decoder 68P81041E43
RQS Detector 68P81041E18
RQS Line Current Generator 68P81041E17
Metering Module 68P81041E38
Sub-Audible Paging 68P81044E56

GENERAL

IMPORTANT

The operation of the transmitter in this radio set is covered by governmental rules and regulations. Several provisions of Federal Communications Commission (FCC) rules are briefly summarized in the following paragraph. For complete information for rules in other countries, refer to the most current applicable regulations.

—Transmitter frequency must be checked before a transmitter is placed in service. While it is not required, it is recommended that the transmitter frequency be checked at the end of the first and third months of service and at one year after installation. This will aid the maintenance technician in detecting frequency changes due to crystal aging. After this initial period, the frequency should be checked once each year. In addition to the frequency check, the transmitter deviation should also be checked and adjusted if necessary.

—The rf power output of a transmitter shall be no more than required for satisfactory technical operation considering the area to be covered and the local conditions.

—Radio transmitters may be tuned or adjusted only by a person holding a valid first or second class commercial radiotelephone operator's license or by personnel working directly under his immediate supervision.

The following sections contain descriptions of the individual components that make up the VHF transmitter in this station. Also included in each section is alignment and maintenance procedural information for the equipment.

NOTE

Each station is equipped with a metering module to facilitate adjustments and troubleshooting of the equipment. If desired, a portable test set may be used to obtain meter readings, however, it cannot be used for keying or modulating the transmitter.

2. DESCRIPTION

The transmitter used in this station develops a frequency modulated output in the 150.8-160 MHz range. Power output can be set to produce an output between 40 and 100 watts. The power output is measured directly from the PA when it is terminated into a non-reactive, 50-ohm load.

NOTE

This station does not make use of "Private-Line" or "Digital Private-Line" in its operation.

2.1 EXCITER

The exciter generates a frequency modulated (crystal-controlled) signal for single channel operation in the 150-171 MHz range. The fundamental crystal frequency is multiplied by twelve to provide the required input to the power amplifier. The output of the exciter is applied to a bandpass filter, whose output is coupled to the FØ relay kit.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

2.2 FØ RELAY KIT

The FØ relay kit allows the output of the first bandpass filter to be applied to the power amplifier (F1 mode) or to the antenna (FØ mode). In the FØ mode, the station outputs a low power (less than 1 watt) carrier without modulation. This mode reduces possible intermodulation interference at multiple transmitter sites.

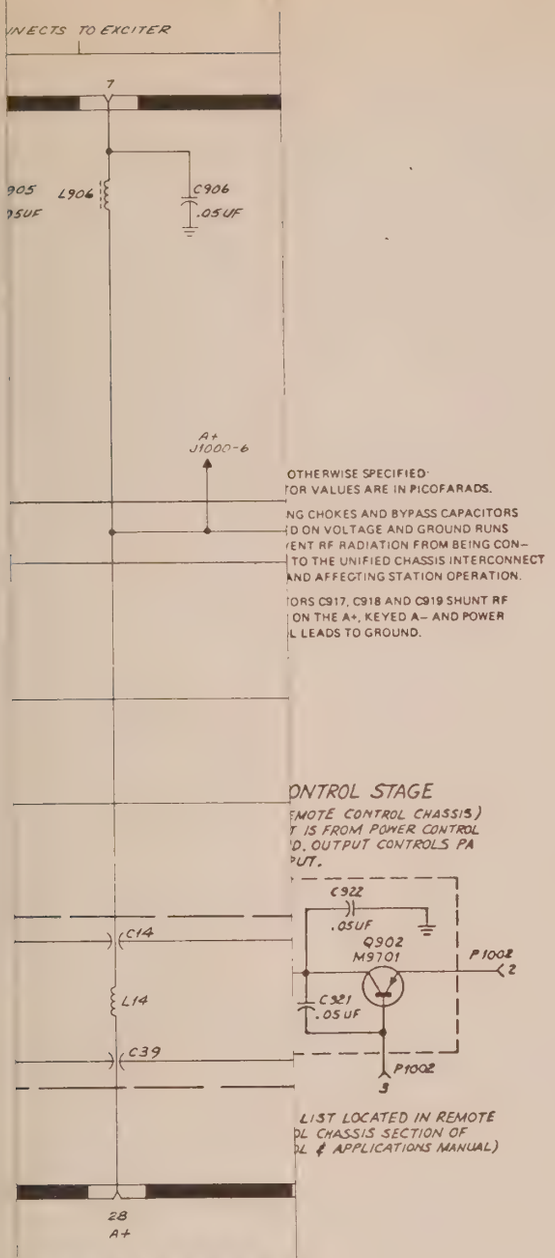
2.3 POWER AMPLIFIER

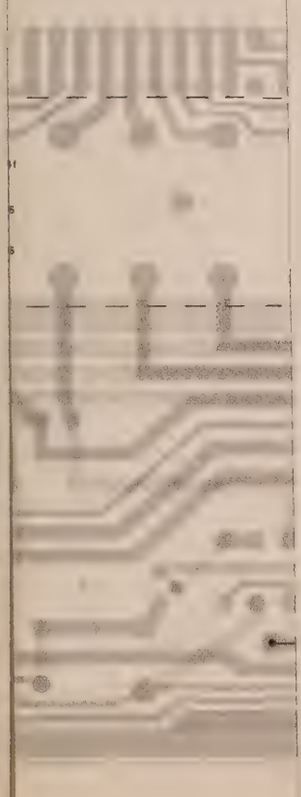
The power amplifier produces the transmitter final rf output power. This output can be power-set from 40 to 100 watts. The PA output is applied, through a harmonic filter, to the power control board. The power control board develops a control voltage that is applied to the controlled stage of the power amplifier to control output power.

2.4 POWER CONTROL BOARD

The power control board circuitry operates as a control loop that continually monitors the final stages of the transmitter. A control stage regulates the gain of the first stage of the power amplifier; from the levels developed by the power control board. The circuitry also provides no-power protection.

The output of the power control board, via the directional coupler, is applied to the wattmeter, options if used (isolators, duplexers, etc.), and then to the antenna.





VN FROM SOLDER SIDE

TRANSMITTER INTERCONNECT BOARD

MODEL TRN8219A

FUNCTION

— Interconnects most transmitter circuit boards to each other (except PA).

— Routes control functions from the unified chassis interconnect board to the transmitter.

— Includes partial control stage circuitry used to govern PA power output.

68P81044E44-O
4/15/79- PHI

MODEL	FREQUENCY
TLD5321A/B	132-150.8 MHz
TLD5322A/B	150.8-174 MHz

TECHNICAL CHARACTERISTICS

	MODEL TLD5321A/B	MODEL TLD5322A/B
FREQUENCY	132-150.8 MHz	150.8-174 MHz
NUMBER OF CHANNELS	1 to 4	
MAXIMUM FREQUENCY SEPARATION	±750 kHz	
OSCILLATOR FREQUENCY	11-14.5 MHz	
FREQUENCY MULTIPLICATION	12 times	
OUTPUT POWER	400 milliwatts	
OUTPUT IMPEDANCE	50 ohms	
MODULATOR TYPE	Direct FM	
DEVIATION	±5 kHz, adjustable instantaneous deviation limiting	
AUDIO RESPONSE	6 dB/octave pre-emphasis 300 to 3000 Hz	
AUDIO SENSITIVITY	165 millivolts for ±3.0 kHz deviation	
AUDIO DISTORTION	Less than 3% at ±3.0 kHz deviation from 300 to 3000 Hz	
POWER REQUIREMENTS	Regulated +9.6 volts dc @150 mA +13.6 volts dc @100 mA	
CONSTRUCTION METERING	Fully solid-state Five test points critical to operation and alignment are accessible at a metering receptacle which permits testing with an optional built-in station meter, Motorola portable test set, or 0-50 uA microammeter with 2,000 ohms series resistance.	

1. DESCRIPTION

1.1 Models TLN5321A/B and TLN5322A/B Exciter provides the low power excitation for an FM transmitter. Up to four plug-in channel elements, one for each transmitter operating frequency, are used to develop a direct FM carrier signal of at least 400 milliwatts.

1.2 The exciter is directly frequency-modulated for crystal-controlled frequency operation in the 132-174 MHz range. It consists of a symmetrical clipper and splatter filter, emitter follower, channel element(s) (voltage controlled crystal oscillator), buffer amplifier, tripler, first doubler, second doubler, and output amplifier. The fundamental crystal frequency is multiplied by twelve to provide the final output frequency.

1.3 When the exciter is used in "Private-Line" stations, a "Private-Line" encoder circuit

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

board is plugged directly into the mating pins of the exciter; and one jumper (JU402) is removed from the exciter; no interconnecting wires are used. The exciter board also includes additional pins that permit the board to be used with certain types of optional equipment. These pins are designated P403 on the exciter schematic diagram.

2. FUNCTIONAL OPERATION

Refer to the exciter block diagram and the exciter schematic diagram included in this section.

2.1 DEVIATION LIMITING CIRCUIT

2.1.1 Microphone output audio is applied to the symmetrical clipper and splatter filter. This circuit, together with amplifier U401, provides pre-emphasis, amplification, and limiting of the microphone audio. Microphone audio is then applied to emitter follower Q401 (together with "PL" code) through IDC control to the channel elements.

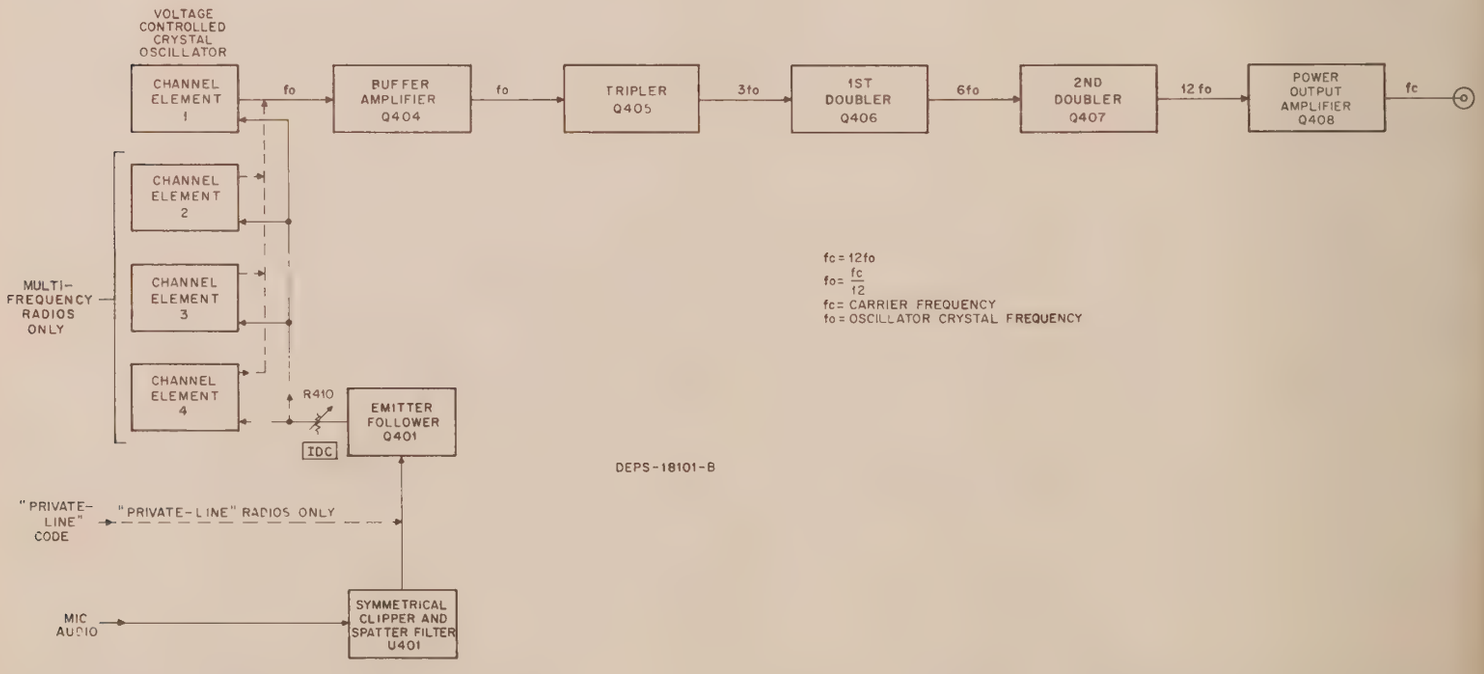
2.1.2 The output of the emitter follower is developed across IDC potentiometer R410. This audio signal can be monitored at pin 1 of the exciter metering receptacle. The potentiometer adjusts the maximum level of audio coupled to the oscillator-modulator, thus setting the amount of deviation.

2.1.3 In "Private-Line" radios, a low amplitude "Private-Line" code is continuously injected into the oscillator-modulator from the "Private-Line" encoder. This code range will produce 0.5 to 1.0 kHz deviation.

2.2 MODULATOR-OSCILLATOR STAGE (CHANNEL ELEMENT)

2.2.1 The combination modulator-oscillator stage (channel element) produces a low-power crystal frequency signal modulator at an audio rate. This signal is multiplied twelve times and amplified in following stages to produce the carrier signal. The channel element consists of a parallel combination varactor and warping capacitor connected in series with a crystal. A change in capacitance seen at the crystal terminals will cause the crystal to vary its resonant frequency in proportion to the capacitance change. The audio voltage from the audio and IDC circuitry is applied to the varactor to cause a change in capacitance; this variation in turn causes the frequency to change at the same audio rate.

2.2.2 Channel elements are highly stable crystal-controlled oscillators. They use unheated crystals in an oscillator circuit that is temperature compensated over the entire temperature range of -30°C to +60°C (-22°F to +140°F). A variable warp capacitor in the base



Exciter Block Diagram

of each channel element is accessible through a hole in the exciter circuit board for fine frequency adjustment. Each channel element is a factory sealed, plug-in module which provides a train of stable frequency positive pulses.

2.2.3 The exciter accepts up to four channel elements - one channel element is required for each frequency. Only one frequency may be selected at a time, but transmission is possible on as many as four separate frequencies. A power input of +9.6 volts is applied to the channel element(s) continuously while the station is turned ON. Channel element output is developed only when a switched ground generated by the local or remote control unit is present. In single-frequency receivers, this switched ground is applied to a specific channel element as determined by the frequency selector switch associated with the station. An indication of the channel element output is available at pin 2 of the metering socket. This allows channel element operation to be easily checked with optional built-in station metering or with a Motorola Portable test set.

NOTE

If the station is equipped with a time-out timer module and the timer times out, keyed A- is removed from the modulator-oscillator(s) and the entire transmitter is shut down.

2.3 BUFFER AMPLIFIER

The buffer amplifier, Q404, is biased to operate as a Class A amplifier and provides reserve gain to isolate the modulator-oscillator from the succeeding stages.

2.4 MULTIPLIERS AND EXCITER POWER AMPLIFIER

2.4.1 The multipliers develop an output signal that is 12 times the channel element frequency and a final power amplifier gives power gain and matches the output impedance to 50 ohms.

2.4.2 The buffer amplifier output is developed across two parallel resonant tank circuits at the channel element frequency. Tripler Q405 operates as a Class C amplifier with its parallel resonant output tuned to the third harmonic of its input. Thus the output of the tripler is three times the channel element frequency. A meter connected at pin 3 of the metering receptacle measures the average dc base current which is proportional to input signal strength.

2.4.3 The first doubler circuit operates very similar to the tripler except its output is tuned to the second harmonic of its input and its drive is metered at pin 4. The output of the doubler is six times the channel element frequency.

2.4.4 The second doubler circuit also operates similar to the tripler with its output tuned to the second harmonic of its input. The drive to the second doubler is metered on pin 5 of the metering receptacle. The output signal is 12 times the channel element frequency and is the carrier frequency of the transmitter.

2.4.5 The exciter power amplifier also operates as a Class C amplifier. The amplifier provides at least 400 milliwatts of frequency modulated signal at the carrier frequency to the power amplifier section of the transmitter.

3. MAINTENANCE

3.1 METERING

The exciter is equipped with a metering receptacle which allows five major test points to be measured. The output of the exciter (input to the power amplifier) can be measured by using the metering receptacle on the power amplifier. With the portable test set connected to the metering receptacles, or by using the built-in station metering kit (if so equipped), readings may be made at each of the major test points in the circuit by merely rotating a selector switch. A failure in almost any portion of the exciter will produce a low or zero meter reading for one or more of the test points. Improper alignment will also cause improper meter readings.

NOTE

The exciter board must be installed in the transmitter for testing to provide the necessary power, ground, control and signal connections. The circuit board should always be secured in place with all mounting screws for operation and testing to provide good rf ground to all stages of the exciter. The exciter may be tested while installed in the station--usually the preferred method. However, if desired, it can be bench tested in a "Micor" mobile radio, except that the time-out timer is inoperative.

TYPICAL EXCITER METER READINGS

SELECTOR SWITCH POSITION	REFERENCE SWITCH POSITION (TEST SET ONLY)	READING	CIRCUIT METERED	IF LOW, THE DEFECTIVE CIRCUIT IS
1	A	2 (no mod) 6 (1 V rms @ 1 kHz exciter board pins 1 & 12)	Audio output of IDC circuit.	IDC circuit
2	A	25	Channel element output.	Channel element
3	A	38	Tripler input	Modulator or Tripler
4	A	22	1st doubler input	Tripler or 1st doubler
5	A	25	2nd doubler input	1st doubler or 2nd doubler

3.1.1 Built-In Station Metering

Step 1. The output of the exciter must be terminated into its normal point, the bandpass filter. The output of the power amplifier must be terminated in a 50-ohm dummy load or an antenna.

Step 2. Turn station ON.

Step 3. Set selector switch to position 1. Key the transmitter and whistle into the microphone long enough to observe the meter reading.

Step 4. Set selector switch to positions 2, 3, 4, and 5 respectively, keying the transmitter and observing the meter readings for each position (whistling not required). On multi-frequency stations, repeat the readings for each exciter frequency. An analysis of the meter readings for determining whether each circuit is good or bad follows in the "Performance Tests" paragraph.

3.1.2 Portable Test Set

Step 1. Connect the 20-pin plug of the test set adapter cable to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve battery life. The plug acts as an on-off switch completing the battery circuit.

Step 2. Connect the red "control" plug of the adapter cable to the control receptacle on the local or remote control circuit board. Connect the white "metering" plug of the adapter cable to the metering receptacle on the exciter circuit board.

Step 3. Set function selector switch to the XMTR position.

Step 4. Set oscillator and meter reversing switch to OFF position.

Step 5. Set 1 V-100 mV switch on the adapter cable to the 100 mV position (TEK-37). On the later version adapter cable (TEK-37A), the switch is omitted and the unit operates at 100 mV sensitivity.

Step 6. Set the REF A-B switch on the adapter cable to position A.

Step 7. The output of the exciter must be terminated into its normal point, the bandpass filter. The output of the power amplifier must be terminated in a 50-ohm dummy load or an antenna.

Step 8. Turn station ON.

Step 9. Connect a microphone to the microphone receptacle on the portable test set or to the local or remote control board.

Step 10. Set selector switch to position 1. Key the transmitter and whistle into the microphone long enough to observe the meter reading.

Step 11. Set selector switch to positions 2, 3, 4, and 5 respectively, keying the transmitter with the XMTR ON pushbutton on the test set or the push-to-talk switch on the microphone and observing the meter reading for each position. On multi-frequency stations, repeat the readings for each exciter frequency. An analysis of the meter readings for determining whether each circuit is good or bad follows in the "Performance Tests" paragraph.

Step 12. Move the "metering" plug to the power amplifier metering receptacle and observe the meter readings for selector switch position 1. The reference A-B switch must be set to the B position and the meter reversing switch to METER REV.

Each time maintenance is performed on the exciter, the readings should be compared

with the previous set of readings. Any degradation of performance will quickly be noted.

3.2 PERFORMANCE TESTS

The performance tests may be used for troubleshooting to isolate the point of abnormal performance. They may also be used after repair and alignment to assure that the exciter meets all specifications before it is returned to service.

3.2.1 Power Output Test

Step 1. Connect the equipment as connected for Metering (paragraph 3.1), except connect the test set "metering" plug to the power amplifier metering receptacle.

Step 2. Set selector switch to position 1. This checks the input to the power amplifier (output of the exciter). A meter reading of at least 20 uA equals an rf signal level of 400 milliwatts.

Step 3. On multi-frequency stations of ±750 kHz separation, repeat the test for each exciter frequency. Select the frequency to be tested by the frequency selector switch associated with the station. The test set meter should indicate at least 20 uA for each frequency.

3.2.2 Frequency Test

Step 1. Terminate the transmitter in an antenna and measure the radiated signal with a Motorola digital frequency meter and deviation monitor or other highly accurate frequency measuring device (±.00005% or better).

NOTE

When high stability channel elements are used, carrier frequency must be within .0002%.

Step 2. Key the transmitter to produce an unmodulated carrier signal. In "Private-Line" tone-coded stations disable the "Private-Line" encoder by unplugging the "Vibrasender" resonant reed. In "Digital Private-Line" stations, disable the code by shorting together the two "code disable" pins on the PL encoder board.

NOTE

Do not use the push-to-talk switch on the microphone. Background noise will modulate the signal.

Step 3. Read the transmitter output frequency. On multi-frequency stations, repeat the test for each frequency.

Step 4. If adjustment is required, set the "warp" capacitor on the associated channel element for the assigned frequency output. For best accuracy, the radio set should be brought to room temperature (+70° to 75°F) and the test equipment thoroughly warmed up. This brings the channel element to the center of its temperature compensation range.

3.2.3 Deviation Test

Step 1. Terminate the transmitter output in an antenna and measure the radiated signal with a deviation meter.

Step 2. In "Private-Line" tone-coded squelch stations, re-insert the "Vibrasender" resonant reed if it was removed in the previous test. In "Digital Private-Line" stations, remove the code disable short. Key the transmitter with only "Private-Line" code modulation. The deviation meter should indicate 0.5 to 1 kHz.

Step 3. Connect an audio oscillator output to exciter board pins 1 (Gnd) and 12 (Audio High). Adjust the audio oscillator to 1000 Hz and 1 volt as measured on an AC voltmeter. The deviation meter should indicate ±5 kHz deviation.

Step 4. Adjust the audio oscillator over the entire 300 to 3000 Hz range, keeping the audio level at approximately 1 volt. The deviation meter should never exceed ±5 kHz nor drop below ±2.5 kHz.

3.2.4 Audio Sensitivity Test

Step 1. After completion of the Deviation Test, reduce the output of the audio oscillator to 130 millivolts at 1000 Hz.

Step 2. The deviation meter should indicate approximately ±3.0 kHz. Meter position 1 may be noted at this time for future reference. Future audio sensitivity checks may then be made by comparing the meter 1 reading with the reference value.

3.3 TROUBLESHOOTING

3.3.1 If there are no test set indications at one or more of the metered points, check the dc input voltages to the exciter circuit board.

P402-11 & 13	+9.6 volts in respect to chassis
P402-6	Keyed A- (approximately -13.6 volts in respect to A+, pin 7).

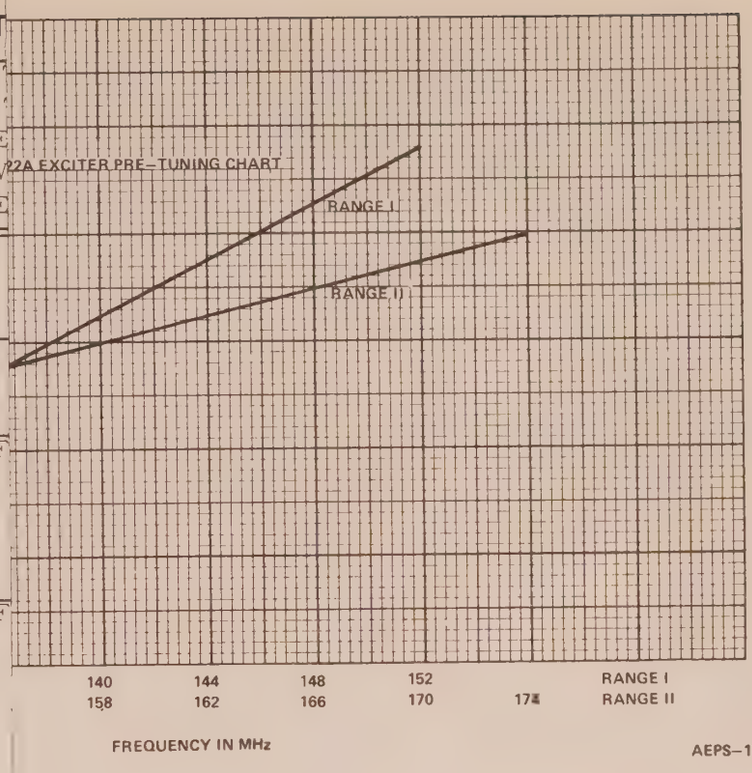
3.3.2 If test set indications localize the trouble to a specific stage or two, measure the dc input voltages to the suspected stages. Refer to the schematic diagram for the normal voltages.

NOTE

In "Private-Line" stations, the transmitter cannot be keyed if the PL encoder is removed unless a jumper (JU402) is connected from pin 8 to pin 10 of the exciter to complete the keying circuit. This jumper is permanently connected in exciters for non-"Private-Line" operation.

ALIGNMENT

STEP	ADJUST	METERING PLUG LOCATION	SELECTOR SWITCH POSITION	METER SWITCH REMOTE SW (SEE
1				
2	POWER SET			
3	FRE-QUENCY SWITCH	EXCITER	2	OFF
4	ALL EXCITER COILS	EXCITER	5	OFF
5	L401	EXCITER	2	OFF
6	L401, L402	EXCITER	3	OFF
7	L403	EXCITER	3	OFF
8	L403, L404	EXCITER	4	OFF
9	L405	EXCITER	4	OFF
10	L405, L406	EXCITER	5	OFF
11	L407 L408	EXCITER	5	OFF
12	L407, L408	PA	1	MET REF
13				
14				



AEPS-17626-O

UENCY ADJUSTMENT

he transmitter with the XMTR ON pushbutton on the one). On "Private-Line" stations, unplug the "Vibra-rator. On "Digital Private-Line" stations short to-rivate-Line" encoder board.

r the selected channel to the exact desired frequency. annel element warp capacitor. On multi-frequency esponds to the frequency selector switch setting; re-

ENT PROCEDURES

TE

iation must be measured with a with RTC-4000A Deviation Meter requency response of less than 1 Hz,

uency before setting "IDC". Connect the audio and 12, Audio High).

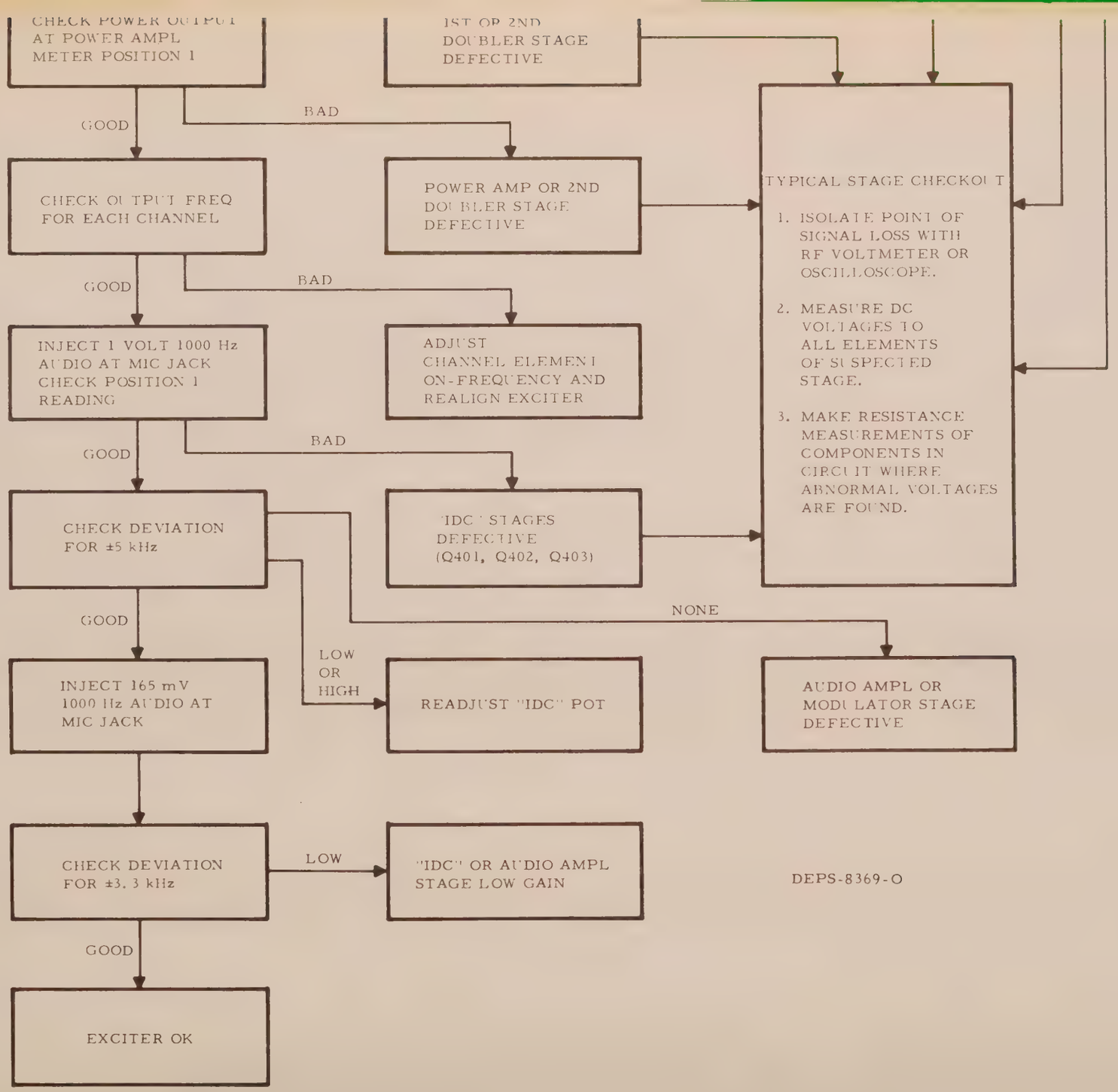
On tone "Private-Line" models, replace the rivate-Line" models, remove the short from

l for ±5 kHz deviation. Essentially full deviation should still be ate a weak audio stage.

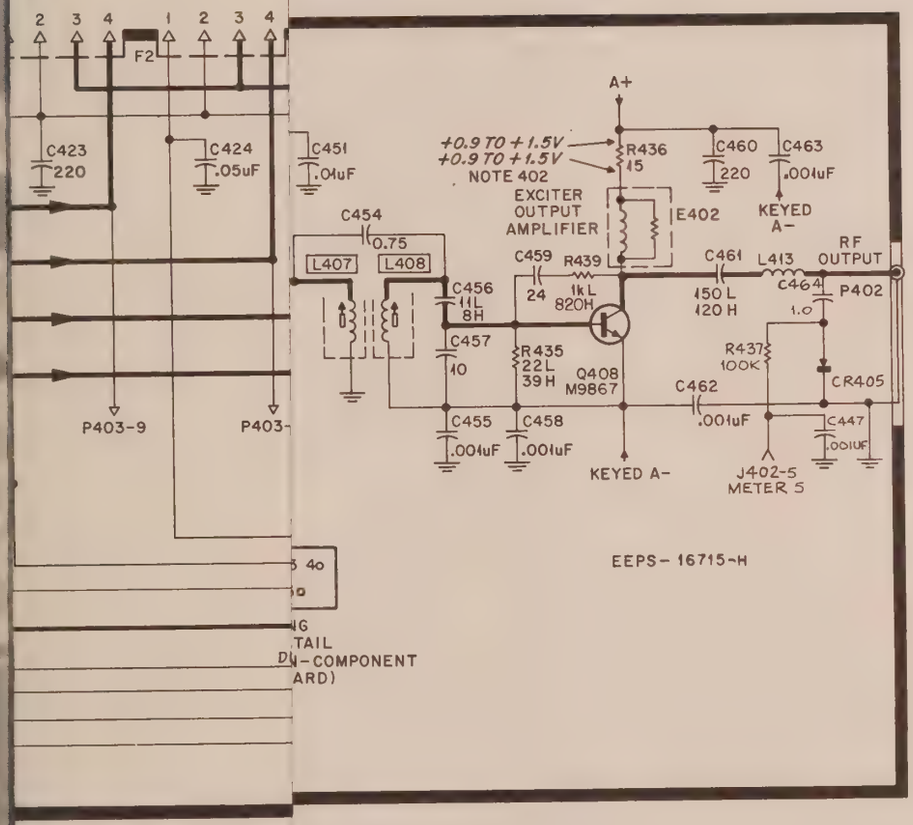
METERI

Alignment may be performed us S1059B Portable Test Set or op ing. The OSC. & METER REV. portable test set usage -- polar as required when built-in statio readings are based on a two-tho series resistance in the meter. a two-thousand ohm series resi corrected.

OTING CHART


CHECK POWER OUTPUT AT POWER AMPL METER POSITION 1
1ST OR 2ND DOUBLER STAGE DEFECTIVE
GOOD
BAD
CHECK OUTPUT FREQ FOR EACH CHANNEL
POWER AMP OR 2ND DOUBLER STAGE DEFECTIVE
TYPICAL STAGE CHECKOUT
1. ISOLATE POINT OF SIGNAL LOSS WITH RF VOLTMETER OR OSCILLOSCOPE.
2. MEASURE DC VOLTAGES TO ALL ELEMENTS OF SUSPECTED STAGE.
3. MAKE RESISTANCE MEASUREMENTS OF COMPONENTS IN CIRCUIT WHERE ABNORMAL VOLTAGES ARE FOUND.
GOOD
BAD
INJECT 1 VOLT 1000 Hz AUDIO AT MIC JACK CHECK POSITION 1 READING
ADJUST CHANNEL ELEMENT ON-FREQUENCY AND REALIGN EXCITER
GOOD
BAD
CHECK DEVIATION FOR ±5 kHz
"IDC" STAGES DEFECTIVE (Q401, Q402, Q403)
NONE
GOOD
LOW OR HIGH
INJECT 165 mV 1000 Hz AUDIO AT MIC JACK
READJUST "IDC" POT
AUDIO AMPL OR MODULATOR STAGE DEFECTIVE
CHECK DEVIATION FOR ±3.3 kHz
LOW
"IDC" OR AUDIO AMPL STAGE LOW GAIN
GOOD
EXCITER OK

DEPS-8369-O



NOTES:

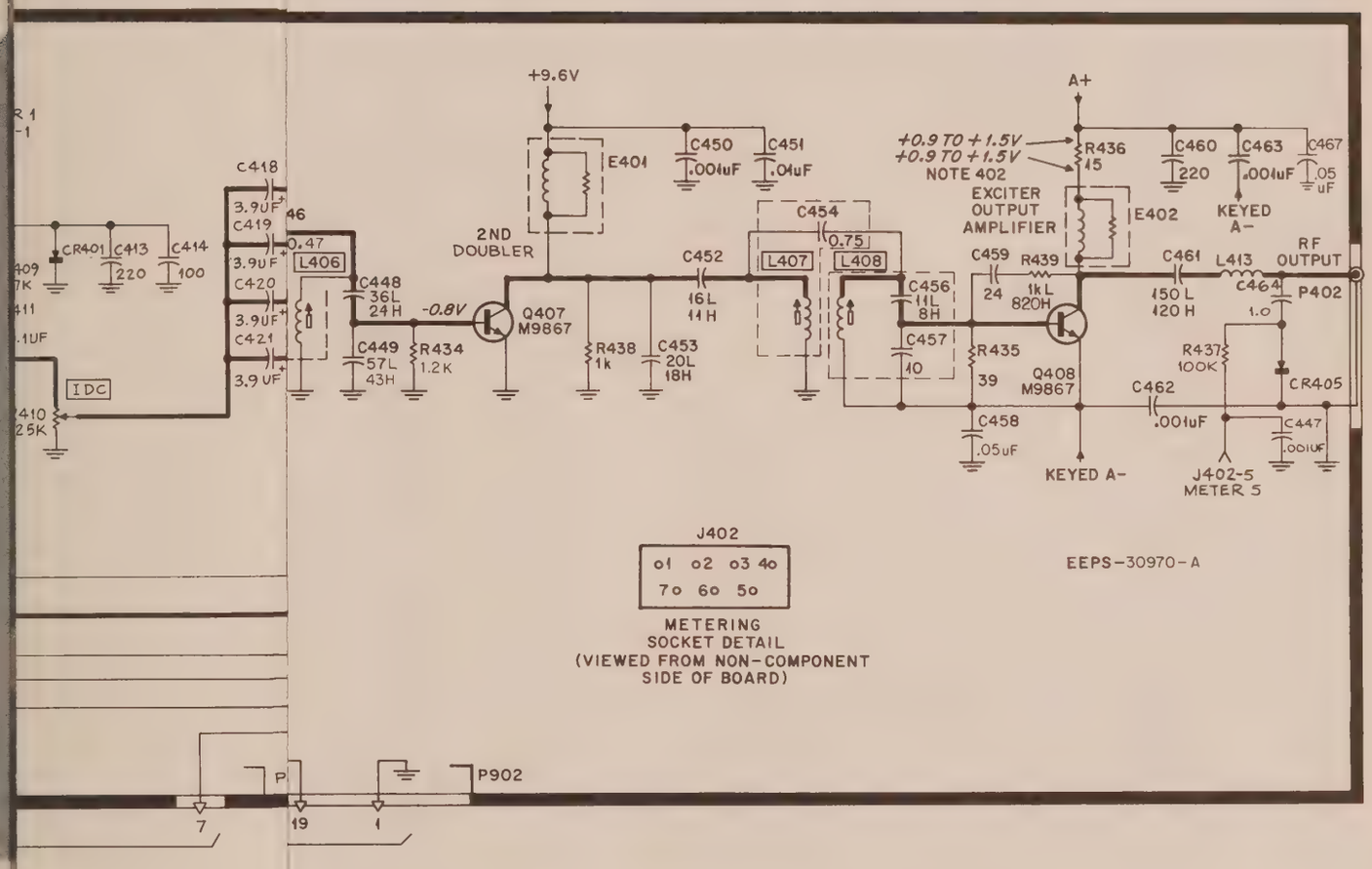
401. TRANSMITTER FREQUENCY CALCULATION:
$fo = \frac{fc}{12}$ $fc = fo\,12$
WHERE:
fo = CHANNEL ELEMENT FREQUENCY
fc = CARRIER FREQUENCY
402. VOLTAGE MEASURED ACROSS R436.
403. HIGH IMPEDANCE TRANSISTORIZED VOLTMETERS (11 MEGOHM) NOT RECOMMENDED.
404. UNLESS OTHERWISE STATED, VOLTAGES MEASURED IN RESPECT TO CHASSIS GROUND.
405. UNLESS OTHERWISE STATED CAPACITOR VALUES ARE IN PICOFARADS.
406. JU401 REMOVED IN "PRIVATE-LINE" RADIOS.
407. R401 REMOVED IN REMOTE CONTROL STATIONS.
408. WHEN CODE INPUTS ARE APPLIED VIA P401-10, R405 MUST BE REMOVED FROM THE CIRCUIT.
409. R404 AND R405 ARE FACTORY SELECTED SO THAT PRIVATE LINE DEVIATION FALLS BETWEEN 500 HZ AND 1000HZ LIMITS.

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

TLD5320A Series Exciter Schematic Diagram and Circuit Board Detail
Motorola No. PEPS-16953-H
6/20/80-PHI

CHECK POWER ON TEST

1ST OP 2ND



PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

TLD5320B and TLD5321B Exciters
Schematic Diagram and Circuit Board Detail
Motorola No. ***PEPS-30974-A***
7/15/81-PHI

90/100/110 W POWER AMPLIFIER

MODEL CHART

TLD1682B	132-150.8 MHz	INTERMITTENT DUTY
TLD1683C	150.8-162 MHz	
TLD1684C	162-174 MHz	
TLD1692D	132-150.8 MHz	CONTINUOUS DUTY
TLD1693E	150.8-162 MHz	
TLD1694E	162-174 MHz	

TECHNICAL CHARACTERISTICS*

RF Power In	400 mW
Input Impedance	50 ohms
RF Power Out	90 W Continuous & Intermittent
	100 W Continuous
	110 W Intermittent
Output Impedance	50 ohms
Power Requirements	12.8 volts @20.5 amps

*All values are typical

1. DESCRIPTION

Motorola's "Micor" power amplifiers provide the following features:

-A minimum of 110 W (intermittent duty) or 100 W (continuous duty) rf output.

-All circuitry except power transistors (and control stage transistor in continuous duty stations) contained on one double-sided circuit board.

-Power transistors mounted directly to (but electrically isolated from) the heat sink.

-RF connections made through two coaxial connections which plug directly into the input and output filter assemblies located below the heat sink shelf.

-DC power supplied via two feed-through capacitors that also provide filtering.

-Input, output and most other interstage matching (with the exception of a single fixed-tuned matching network between the controlled amplifier stage and the pre-driver stage) is accomplished by the use of rf transformers wound around ferrite cores. Only two tuning adjustments are required due to the relatively broadband matching characteristics of the ferrite transformers and the low inductance leads of the silicon opposed emitter transistors.

-One metering socket which is accessible from the component side of the circuit board allows four major test points to be monitored and permits measurement of the dc current drawn by the final amplifier stage.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

- Due to the heat sink mounting requirements for this board, servicing is accomplished from the component side of the board.

- Diode protection against reverse polarity voltage (board mounted diode).

- Output protection provided by a control stage transistor driven by power control circuit. (Controls gain of the first stage). In intermittent duty stations, a single-wire connection provides interconnection between power control and PA circuitry. In continuous duty stations three wire connections provide the interconnection.

2. FUNCTIONAL OPERATION

Refer to the block diagram, Figure 1, and the schematic diagram. This series of power amplifiers requires a 400 mW rf input from the exciter board. This input is passed through a bandpass filter assembly and a ferrite step-down transformer (to match the input impedance to the first stage) to the gain-controlled amplifier stage. The external power control circuit which drives the control stage transistor determines the gain of this stage. The power control circuit monitors the output of the final stages of the power amplifier, the load condition and the heat sink temperature.

The output of the gain-controlled amplifier is passed through a fixed-tuned broadband matching network and applied to the pre-driver stage. A second ferrite transformer is utilized to match the single-ended output of the pre-driver stage to the input of the push-pull driver stage. The output of the driver stage is split by a pair of transformers to drive each of the push-pull final power amplifier stages. The output from each final stage is stepped up in impedance by ferrite transformers and paralleled to provide the 50-ohm output impedance to match the input impedance of the harmonic filter.

Pin 1 of the metering receptacle provides a means of checking the incoming signal from the exciter. Pin 2 permits observation of the drive output of the first stage and an indication of the operation of the pre-driver stage. Pins 3 and 4 reflect the output drive signal and operation of the two push-pull power amplifier stages. Reference position A on a Motorola Portable Test Set uses pin 7 of the metering socket as an A+ reference against which the outputs of pins 1, 2, 3, and 4 are checked. Switch the test set to reference position B which uses pin 6 as a reference and then switch to meter position 5. This provides a reading across a calibrated resistor through which the current is drawn by the final amplifier stages.

3. MAINTENANCE

a. General

NOTE

Because of the complexity involved and time required to remove the PA board, compared to plug-in boards, it is not recommended that the PA board be removed. Proper troubleshooting techniques will usually locate defective components "on the spot".

This section of the manual provides the maintenance shop procedures for the PA board. It assumes that preliminary tests have already localized the trouble to the PA board. These procedures include measurements with optional built-in metering or a Motorola portable test set, a vom, a complete set of performance tests, and extensive troubleshooting procedures.

CAUTION

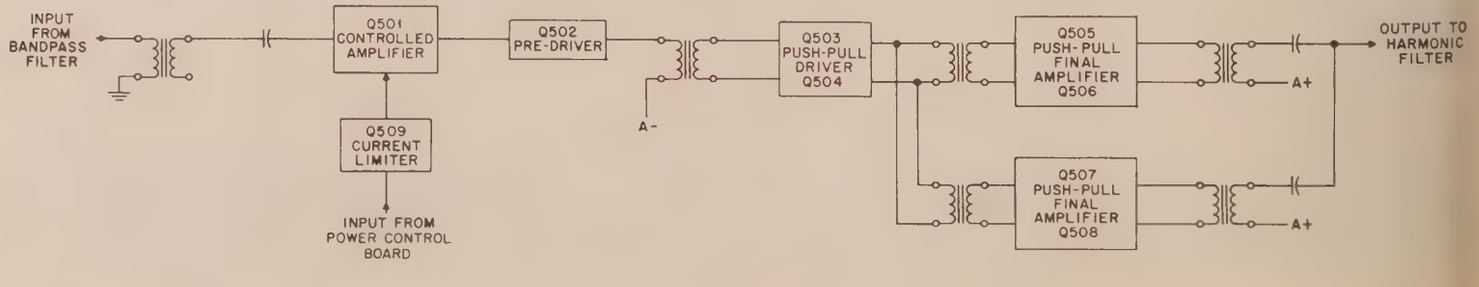
The PA board must be installed in the transmitter for testing to provide the necessary power, ground, control, heat sinking and signal connections.

b. Recommended Test Equipment

The following test equipment is the minimum required for troubleshooting and adjusting the PA. All such equipment is battery operated which permit testing to be performed in the field where no commercial power is available for bench type test equipment. Option built-in station metering when incorporated takes the place of the portable test set.

(1) Motorola S1056B through S1059B Portable Test Set and Model TEK-37 or TEK-37A Adapter Cable. The portable test set is required for checking each stage for proper operation.

(2) A Motorola Solid-State DC Multimeter or a 20,000 ohm-per-volt multimeter should be used, however a low impedance multimeter is acceptable for dc voltage measurements only.



69D81008E43-A

Figure 1. Block Diagram

(3) Motorola T1013A RF Load Resistor (dummy load) or equivalent.

c. Test Set Metering

The PA is equipped with a metering receptacle which allows five major test points to be measured. PA metering can be made at each of the five test points by merely rotating a selector switch on the built-in station meter kit or on the test set. A failure in almost any portion of the PA will produce a low or zero meter reading for one or more of the test points. Improper alignment will also cause improper meter readings.

(1) Using the Optional Built-In Station Meter

This procedure is valid only with intermittent duty station. Continuous duty stations with built-in station metering measure only exciter output (PA input), PA current, and PA voltage.

a. The entire transmitter is necessary for testing PA boards including the power control board for proper control.

b. The output of the station must be terminated in one of three types of loads:

--The antenna load.

--A dummy load such as Motorola's T1013A RF Load Resistor.

--An RF Wattmeter.

NOTE

A dummy load is preferred to the antenna to eliminate the possibility of shutback by the power control board due to a defective antenna.

c. Turn the station ON.

d. With the meter selector switch set to position 1, key the transmitter and observe the meter. Unkey the transmitter.

Set the selector switch to position 2, 3, and 4 keying the transmitter and observing the meter reading for each. On multi-frequency stations, repeat the readings for each frequency. An analysis of the meter readings for determining whether each circuit is good or bad follows the "Using the Portable Test Set" paragraphs.

(2) Using the Portable Test Set

To make the measurements, the portable test set must be connected to the station as follows.

a. Set the function selector switch of the portable test set to the XMTR position.

b. Set the meter reversing switch of the test set to the METER REV position, the selector switch to position 1, and REF switch to position A.

c. Connect the 20-pin meter cable plug to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve battery life. The plug acts as an on-off switch completing the battery circuit.

d. Connect the red "control" plug of the adapter cable to the control receptacle on the local or remote control board. Connect the white "metering" plug of the adapter cable to the receptacle on the PA circuit board.

e. The entire transmitter is necessary for testing PA boards including the power control board for proper control.

f. The output of the station must be terminated in one of three types of loads:

--The antenna load.

--A dummy load such as Motorola's T1013A RF Load Resistor.

--An RF Wattmeter.

NOTE

A dummy load is preferred to the antenna to eliminate the possibility of shutback by the power control board due to a defective antenna.

g. Turn the station ON.

h. Key the transmitter with the XMTR ON button on the test set. Observe the meter. Unkey the transmitter.

i. Set the selector switch to positions 2, 3, & 4; then switch to reference position B and meter position 5 respectively, keying the transmitter and observing the meter reading for

each. On multi-frequency stations, repeat the readings for each frequency. An analysis of the meter readings for determining whether each circuit is good or bad follows.

Each time maintenance is performed on the PA the readings should be compared with the previous set of readings. Any degradation of performance will quickly be noted. Often, a lower reading may indicate an impending failure and corrective action may be taken before the circuit fails entirely.

d. Performance Tests

(1) No performance test of the power amplifier is required other than rf power output from the station as a whole. Before checking power output:

(a) The exciter board should be known to be operating normally.

(b) The power control board should be known to be functioning normally.

(2) Key the transmitter and observe power out, which should be 90, 100, or 110 watts, depending upon licensing.

MINIMUM PA METER READINGS

SELECTOR SWITCH POSITION	REFERENCE SWITCH POSITION PORTABLE TEST SET ONLY	MINIMUM METER READINGS	CIRCUIT METERED	IF LOW, DEFECTIVE CIRCUIT IS: (SEE TROUBLESHOOTING CHARTS)
1	A	15 uA	Exciter Output (input to Controlled Amplifier Q501)	Exciter output, input circuitry of controlled amplifier stage Q501
2	A	5 uA	Input of Predriver Stage (Q502)	Output of controlled amplifier stage input circuitry of predriver stage
3	A	12 uA (100 W/ 110 W) 10 uA (90 W)	Input of Final Amplifier Stage Q505, Q506	Input of Q505, Q506 stages, output of driver stage (Q502, Q503), output of predriver stage Q502
4	A	12 uA (100 W/ 110 W) 10 uA (90 W)	Input of Final Amplifier Stage Q507, Q508	Input of Q507, Q508 stage output of driver stage Q502, Q503., Output of predriver stage Q502
5 (or 2 SEE NOTE)	B	21 uA min. / 27 uA max. — 90 W 23 uA min. / 37 uA max. — 100 W / 110 W	Total Current in Final Amplifier Stages Q505, Q506, Q507, Q508	Output of final amplifier stages Q505-Q508, power control board antenna switch, antenna.
6 (or 3 SEE NOTE)	B	12 V (0-30 V scale)	Final Amplifier Stage	Final amplifier stage A+ or A- input

NOTE

When optional built-in station metering is used in continuous duty stations, only exciter output (PA input), final PA current, and final PA voltage may be checked. Selector switch position functions change to:

SELECTOR SWITCH POSITION	FUNCTION METERED
1	PA input
2	PA current
3	PA voltage
4	Forward power monitor
5	Reflected power monitor
6	Control voltage

(3) If necessary, adjust POWER SET control for rated power output.

CAUTION

The PA shield must always be in place during operation of the radio set and should be kept in place as much as possible while testing and troubleshooting. The circuit board must always be secured in place with all mounting screws. The transistors (including the control stage transistor) must be secured in place to provide proper heat sinking, and the feedthrough connectors must be soldered in place to provide dc power and good rf grounding.

4. TROUBLESHOOTING

If a problem has been localized to the PA decks, several checks can be made prior to extensive troubleshooting.

a. Visual

Visually check for obvious physical defects such as broken leads, broken plating, broken or disconnected components or overheated parts. Before any attempt is made to change parts, the circuit should be checked to insure that the problem causing the original failure has been identified and corrected, otherwise damage to the new part may occur.

b. Voltage Checks

Check for A+ and A- at the feedthrough connections and for proper voltages at the collectors of each transistor. Certain defects such as broken plating, broken leads etc. may not be obvious to a visual inspection.

c. Troubleshooting

If test set readings are abnormal or tests indicate subnormal performance, a logical troubleshooting procedure is required to isolate the defective component efficiently. The accompanying troubleshooting chart summarize these results in a logical sequence. A few voltage and resistance checks in the suspected circuit should readily isolate the defective component. Note that all power for the circuits in the PA is from A- referenced to A+ (not to chassis ground, this feature allows operation from positive or negative ground power sources when an optional positive ground converter is used).

CAUTION

Due to the voltage requirements of P-N-P transistors, all "rf ground" plating is A+ and is "hot" with respect to chassis ground in negative ground applications. Because of this, caution should be used to prevent connection of "ground" plating on the PA board to chassis ground, either directly or by the use of test equipment ground leads. If ac operated test equipment is used, the ground lead must not be electrically connected to ac line ground.

The schematic diagram of the PA board contains the voltage readings required for troubleshooting. The readings are typical for normal operating conditions at rated power output for the radio. Refer to the troubleshooting chart, and the schematic when a defect is suspected in the PA board.

5. PA REPAIR NOTES

a. Resistance Measurement of Transistors in Push-Pull Pairs

Due to the fact that transistors in push-pull pairs are dc connected at both base and emitter,

BOTH devices should be measured when a defect in the pair is suspected.

b. Transistor Removal Procedure

(1) Unscrew both mounting screws from the base of the transistors. The nuts (for the mounting screws) on the reverse side of the shelf are captivated and will not fall out.

(2) Remove excess solder from around transistor tabs with a vacuum bulb type de-soldering device.

(3) Gently lift each lead, one at a time while applying heat.

(4) When all four leads are loose from the board carefully lift out the transistor.

c. Transistor Installation Procedure

(1) Pre-tin underside of each transistor lead.

(2) Apply a light coat of Wakefield Thermal Compound to the underside of the transistor mounting base and to the heat sink.

(3) Install the transistor making sure that all collector leads face the proper direction. Refer to the circuit board detail.

(4) Screw down the two mounting screws securely.

(5) Solder each transistor lead one at a time to the circuit board. The use of a generous amount of solder will insure a good contact of the entire tab to the board. Use care that solder does not bridge to other plating or that solder does not flow into the cutout in the circuit board.

d. Procedures for Resistance Measurements of Transistors

(1) Set ohmmeter to RX1, RX10 or RX100 scale (preferably RX10 if available).

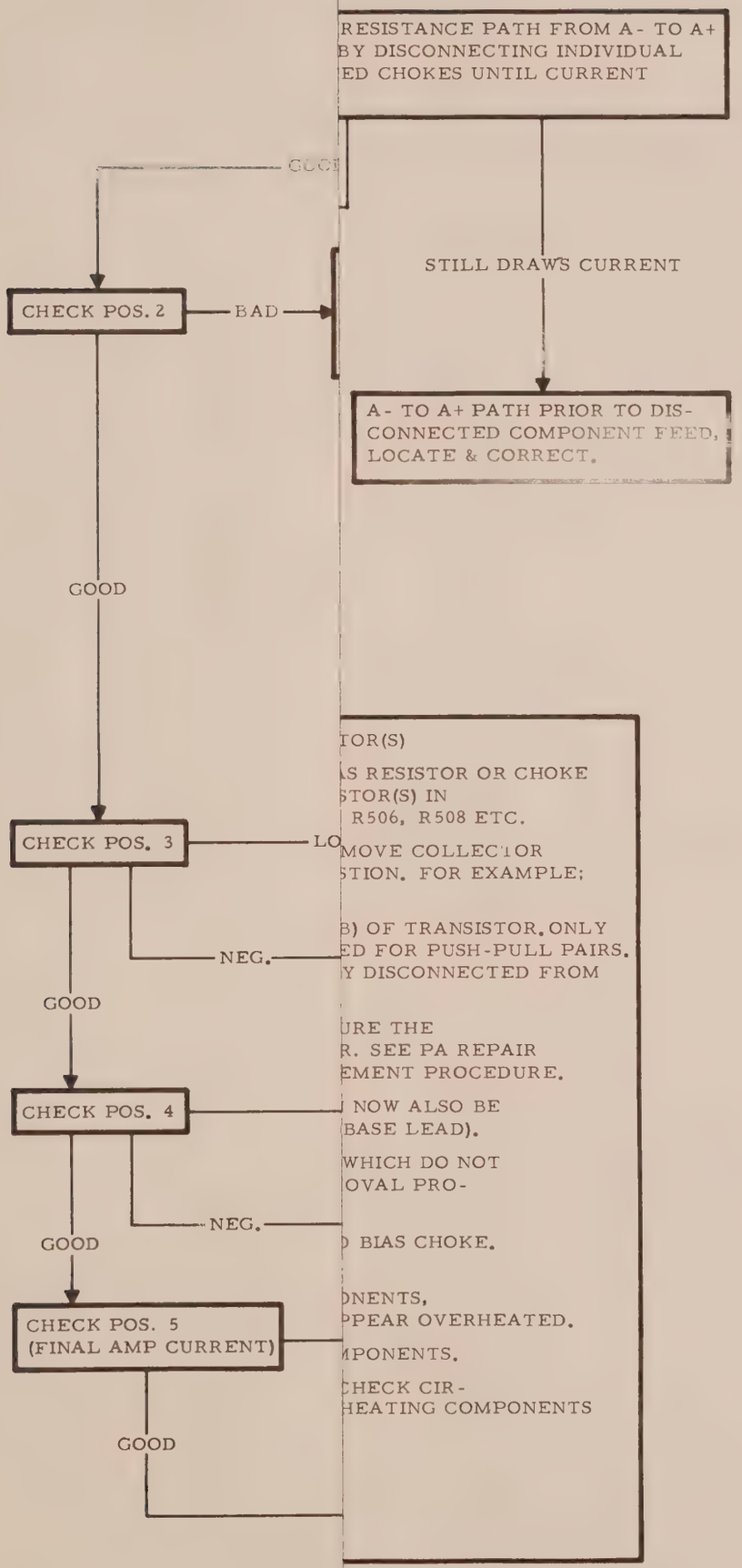
(2) Measure the resistance from lead to lead as described:

(a) With the positive probe on the base, no indication (very high impedance) should be observed when the negative probe is touched to the collector or emitter. (Reverse drop measurement

(b) With the negative probe on the base, a relatively low impedance should be observed when touching the positive probe to the collector and emitter. (Forward drop measurement.)

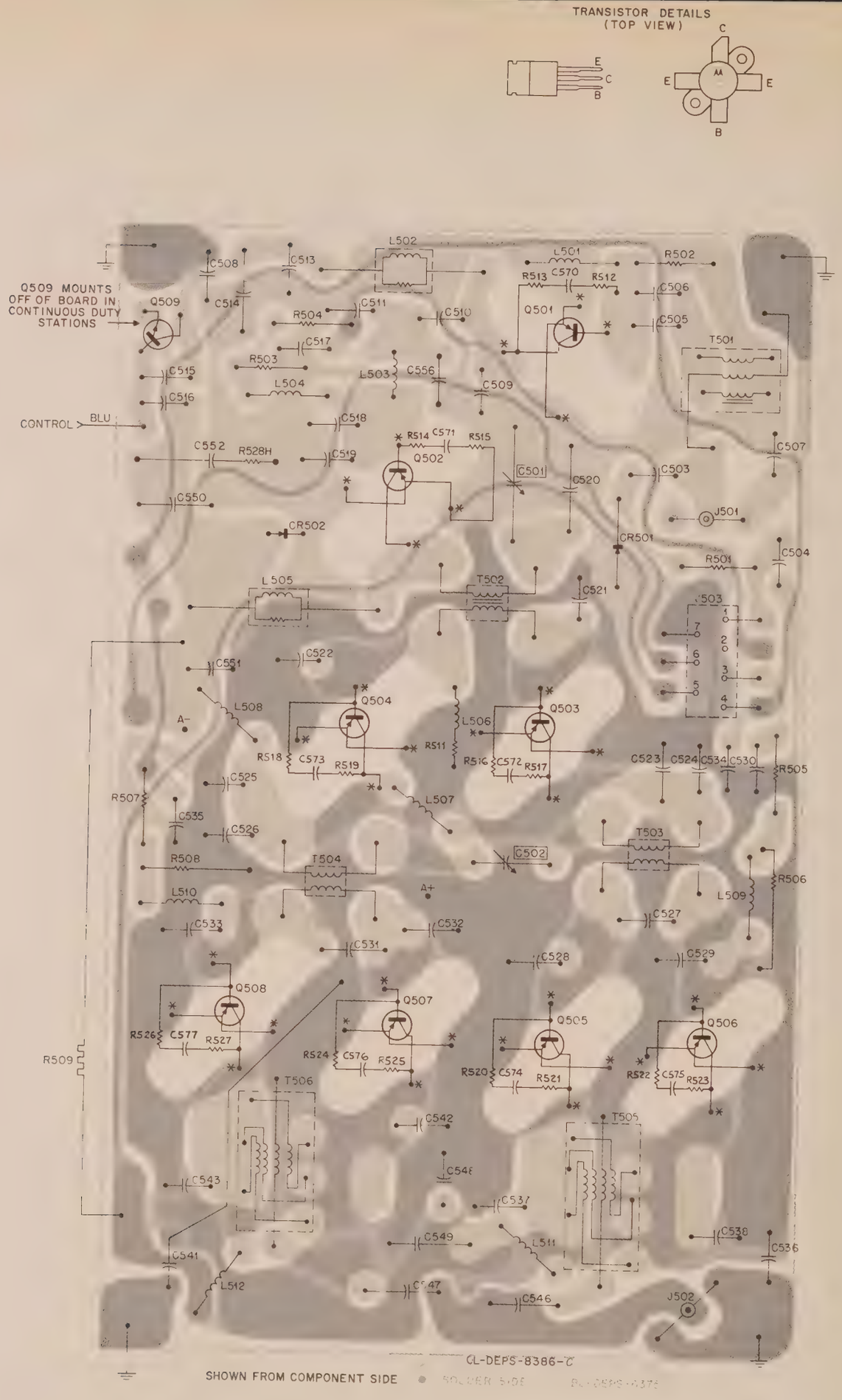
(c) No indication should be observed from collector to emitter regardless of the polarity of the ohmmeter probes.

Should any indication be observed in measurements (a) or (c), the transistor is defective and should be replaced.


RESISTANCE PATH FROM A- TO A+
BY DISCONNECTING INDIVIDUAL
ED CHOKES UNTIL CURRENT
STILL DRAWS CURRENT
CHECK POS. 2
BAD
A- TO A+ PATH PRIOR TO DIS-
CONNECTED COMPONENT FEED,
LOCATE & CORRECT.
GOOD
TOR(S)
S RESISTOR OR CHOKE
STOR(S) IN
R506, R508 ETC.
CHECK POS. 3
MOVE COLLECTOR
STION. FOR EXAMPLE;
B) OF TRANSISTOR. ONLY
ED FOR PUSH-PULL PAIRS.
Y DISCONNECTED FROM
NEG.
GOOD
URE THE
R. SEE PA REPAIR
EMENT PROCEDURE.
CHECK POS. 4
NOW ALSO BE
BASE LEAD).
WHICH DO NOT
OVAL PRO-
NEG.
GOOD
BIAS CHOKE.
ONENTS,
PPEAR OVERHEATED.
CHECK POS. 5
(FINAL AMP CURRENT)
MPONENTS.
CHECK CIR-
HEATING COMPONENTS
GOOD

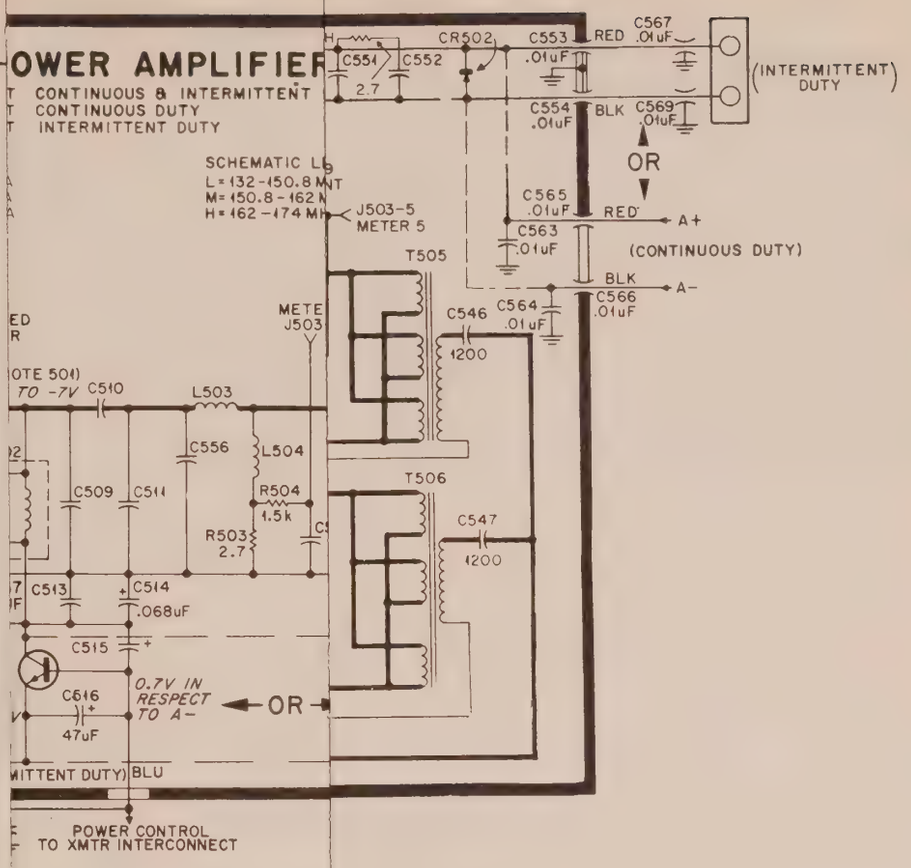
POWER AMPLIFIER ALIGNMENT PROCEDURE (CONT'D)

STEP	ADJUST	METERING PLUG LOCATION	SELECTOR SWITCH POSITION	METER REV. & ADAPTER CABLE REF. SWITCHES (SEE NOTE)	STAGE AND PROCEDURE
5	C501, C502	POWER CONTROL BOARD	5	METER REV. REF B	PA DRIVER OUTPUT - Tune C501, then C502 for a minimum meter 5 reading.
6	POWER SET	POWER CONTROL BOARD	Wattmeter or 1	METER REV. REF A	OUTPUT - Adjust the POWER SET control for rated power output and perform step 5. (If rated power cannot be attained, repeat steps 4 and 5.)
			5	METER REV. REF B	Check meter 5 reading, it must not exceed 50 uA.
7		PA	5	METER REV. REF B	FINAL COLLECTOR CURRENT - Move the metering plug to the PA. Measure the final collector current (I_c). I_c in amperes is the meter 5 reading (0-50) x 1/2.
8		PA	6	METER REV. REF B	FINAL COLLECTOR VOLTAGE - Measure the final collector voltage (V_c). V_c is the meter 6 reading (0-30 volt scale).
9					Determine final input power (P_{in}). P_{in} equals $V_c \times I_c$. P_{in} should be less than: 180 watts for 90-wat models; 200 watts for 100-watt continuous duty models and 110-wa intermittent duty models.



* THESE TRANSISTOR LEADS ARE CONNECTED TO ONLY THE COMPONENT SIDE OF THE BOARD

90/100/110 W Power Amplifier
Circuit Board Detail
Motorola No. PEPS-18126-A
6/15/79-PHI



PARTS LIST SHOWN ON
BACK OF THIS DIAGRAM

90/100/110 W Power Amplifier
Schematic Diagram
Motorola No. PEPS-26753-O
6/15/79-PHI

ROLA T NO.	DESCRIPTION
	RESISTOR, fixed: ±10%; 1/4 W; unless otherwise stated
97	100k
02	150k
01	10 ±5%
17	47
55	2.7 ±5%
53	1.5k
65	4.7k
70	1; 1/2 W
2B01	(meter shunt)
55	2.7 ±5%
55	2.7 ±5%
	TRANSFORMER, RF:
96B01	pri: 5 turns sec: 4 windings, 1 turn each
97B01	pri: 2 windings, 1-3/4 turns each sec: 2 windings, 1-3/4 turns each
59L01	pri: 2 windings, 2-3/4 turns each sec: 2 windings, 2-3/4 turns each NOTE: ("Left hand" windings)
54L01	pri: 3-3/4 turns sec: 3-3/4 turns
60L01	pri: 2 windings, 2 turns each sec: 2 windings, 2 turns each
59L02	pri: 2 windings, 2-3/4 turns each sec: 2 windings, 2-3/4 turns each NOTE: ("Right hand" windings)
54L02	pri: 3-3/4 turns sec: 3-3/4 turns
60L01	pri: 2 windings, 2 turns each sec: 2 windings, 2 turns each
60L01	pri: 3 windings, 1-1/2 turns each sec: 6 turns
61L01	pri: 3 windings, 1-1/2 turns each sec: 5 turns
60L01	pri: 3 windings, 1-1/2 turns each sec: 6 turns
61L01	pri: 3 windings, 1-1/2 turns each sec: 5 turns

ilter PL-1722-O

	FILTER, RF: low pass;
101A	132-150.8 MHz
102A	150.8-174 MHz

Bracket Kit PL-1856-O

	CAPACITOR, fixed:
11B01	.01 uF +100-0%; 250 V

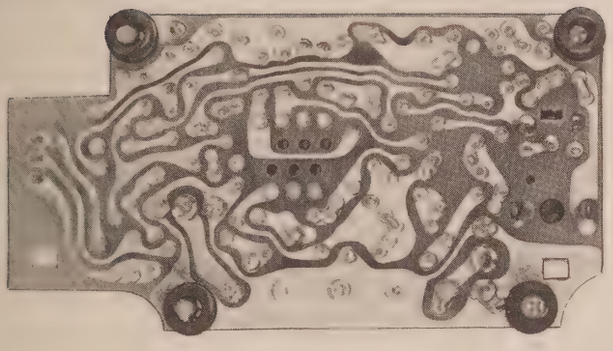
TLN5074A is listed in the Transmitter section.

TRN8069A Resistor-Capacitor Network Kit (132-150.8 MHz)
TRN6445A Resistor-Capacitor Network Kit (150.8-162 MHz)
TLD5502A Resistor-Capacitor Network Kit (162-174 MHz) PL-5396-A

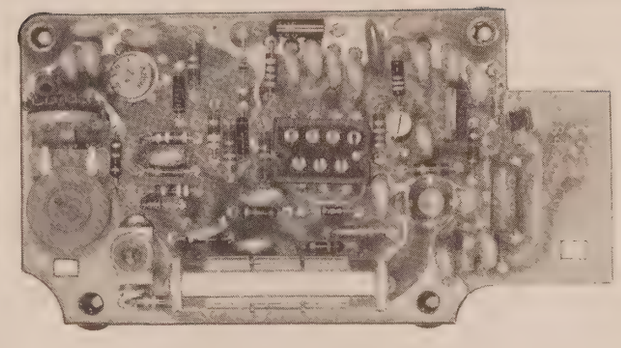
		CAPACITOR, fixed:
C570, 572 thru 577	8-83813H05	.068 uF ±10%; 100 V
C571L		Not Used
C571M, 571H	8-83813H05	.068 uF ±10%; 100 V
		RESISTOR, fixed:
R512, 513	6-125C25	100 ±10%; 1/2 W
R514L, 515L		Not Used
R514M, 515M	6-125C25	100 ±10%; 1/2 W
R514H, 515H	6-125A18	51 ±5%; 1/2 W
R516 thru 527	6-125C03	12 ±10%; 1/2 W

POWER CONTROL BOARD

MODELS TLD8610A & TLD8620A
TLD8610AV & TLD8620AV
& TLD5960A



TOP VIEW



BOTTOM VIEW

FAEPS-6127-A

MODEL TABLE

MODEL	POWER RANGE
TLD8610A & TLD8610AV	60 W
TLD8620A & TLD8620AV	90/110 W Intermittent
TLD5960A	100 W Continuous

1. DESCRIPTION

The solid-state power control board provides regulation and protection for the rf transistors. One model is used with all 60-watt stations--the other model is used with 100-watt continuous duty stations and 90 or 110-watt intermittent duty stations. The following four functions are provided by the circuitry.

--Power Leveling - The board permits the adjustment of the output of the power amplifier to the proper level and then maintains that level of output regardless of power or supply voltage fluctuations as long as the gain of the power amplifier is equal to, or above, the preset level.

--VSWR Protection - A voltage standing wave ratio (VSWR) detector operates during transmitting periods to prevent over-dissipation of the final amplifier transistors should a fault occur in the antenna circuit. The circuitry compares power reflected from the antenna circuit to forward (output) power. When this ratio exceeds a predetermined amount, the output of the circuit lowers the power output of the power amplifier.

--Temperature Protection (Intermittent Only) -- A portion of the circuitry continually monitors heat sink temperature. When a temperature of approximately 80°C is reached, the power control board begins to reduce the power amplifier output to prevent damage to the final stage

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

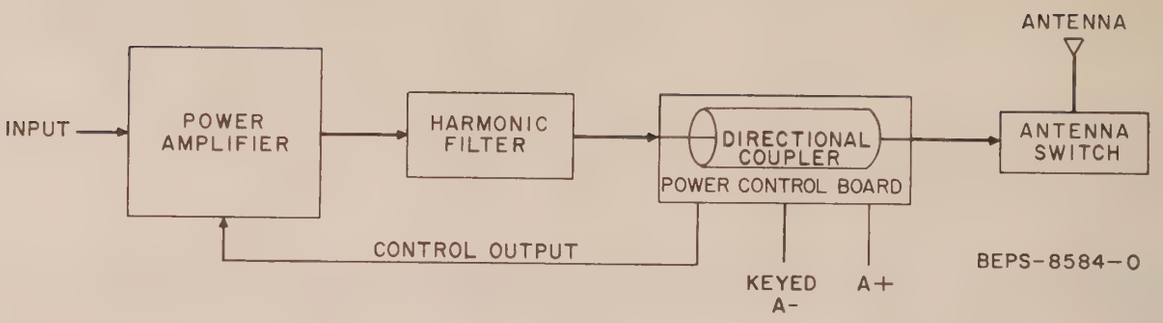


Figure 1.
Loop Block Diagram

power transistors. Any further increase in heat sink temperature will cause a correspondingly greater decrease in power output. A reduced power output level will be maintained until the heat sink temperature drops below 80°C. Thermal protection is not needed on the continuous duty version due to the large heat exchanger used.

--Forward and Reverse Power Metering- Metering points on the board provide a means of monitoring the amount of forward (output) and reflected (reverse) power in the load system.

The power control board is constructed on a single circuit board which is easily removed and replaced. All external connections are made by two coaxial connectors (input and output for the dual directional coupler) and three pins which plug into the control board. All metering points and the single adjustment point are accessible from the plating side of the board.

2. FUNCTIONAL OPERATION

Refer to the loop block diagram, Figure 1. The circuitry operates as a control loop which continually monitors the output from the final stages of the transmitter power amplifier and controls that output by regulating the gain of the first stage of the power amplifier.

Refer to the block diagram, Figure 2. The output of the integrated circuit differential amplifier, amplified by the dc amplifier is the controlling input to the power amplifier board.

The output of the differential amplifier is determined by the potentials present on the non-inverting (+) and inverting (-) inputs. These potentials are developed by the power control board circuitry in the following manner.

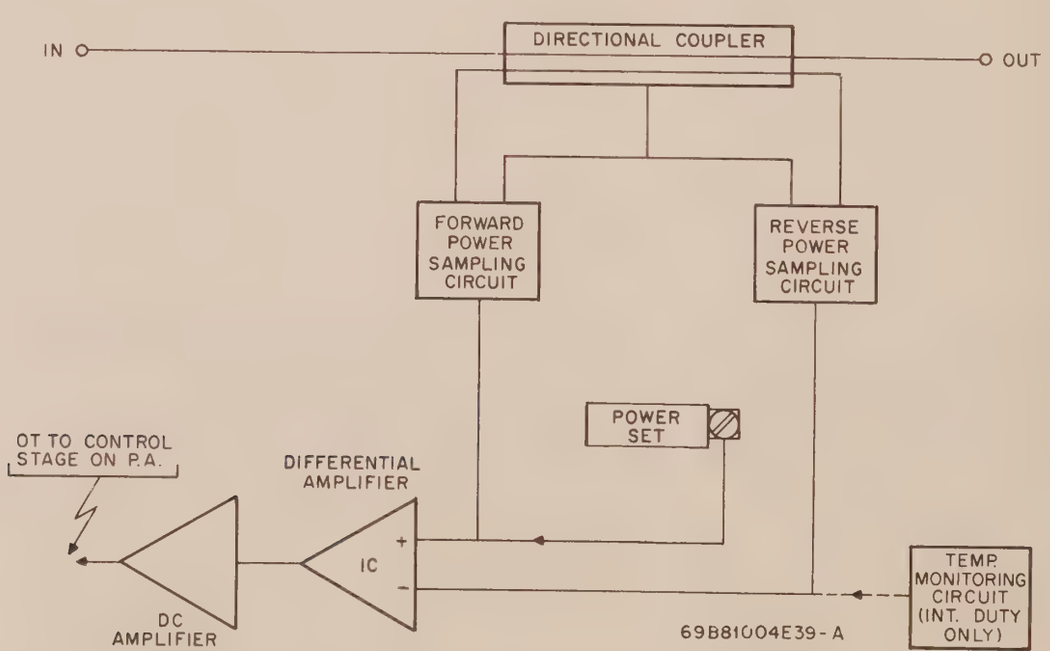


Figure 2.
Power Control Board Block Diagram

When the impedances of the antenna circuitry (load) and the power amplifier are matched (a VSWR of 1:1), and the heat sink temperature is below 80°C (for intermittent duty stations), a bias voltage produced by the dc reference bias circuitry is placed on the inverting input (also called the "reference input") of the differential amplifier (see Figure 5).

When the transmitter is keyed, the forward (output) power from the final stages of the power amplifier is fed through the directional coupler to the antenna circuit. This flow of power is sampled by the forward power sampling circuitry and places a bias, proportional to the forward power, on the non-inverting input (pin 5) of the differential amplifier. The POWER SET potentiometer is then adjusted, changing the potential on the non-inverting input. As this voltage changes, relative to the reference input voltage, the output of the differential amplifier changes, in turn changing the loop control level and therefore the output of the power amplifier.

Once the power has been set to the proper level, any change in the output power will be instantly corrected by the circuitry. If the power increases, the increase causes the differential amplifier output voltage to increase, decreasing the output from the dc amplifier which decreases the gain of the power amplifier until the output returns to the preset level. A decrease in transmitter power amplifier output causes the reverse action.

Any power reflected back from the antenna circuit is detected by the reverse power sampling circuit. Reverse power causes a negative current to flow, which, in turn, decreases the potential on the reference input of the differential amplifier. Therefore, increasing levels of reflected power will cause the transmitter power output to be decreased to a safe level.

On intermittent duty stations, temperature increases detected by the temperature monitoring circuit will also decrease the reference level at the inverting input of the differential amplifier, reducing the output power as the heat sink temperature increases above a safe operating point for the power transistors. The higher the temperature, the more the decrease in power out. If the output has been reduced due to temperature, the VSWR circuit becomes more sensitive to reverse power, thus providing further protection for the rf power amplifier transistors.

3. CIRCUIT DESCRIPTION

a. Bias Circuitry

Since the power control board has the capability to regulate the output of the transmitter power amplifier from a completely cut-off state to above the rated output power, a definite controlled output level is necessary whenever the transmitter is keyed. The desired controlled output level is determined by bias voltages present on the inverting and non-inverting inputs of the differential amplifier IC601 (see Figure 3.). Under

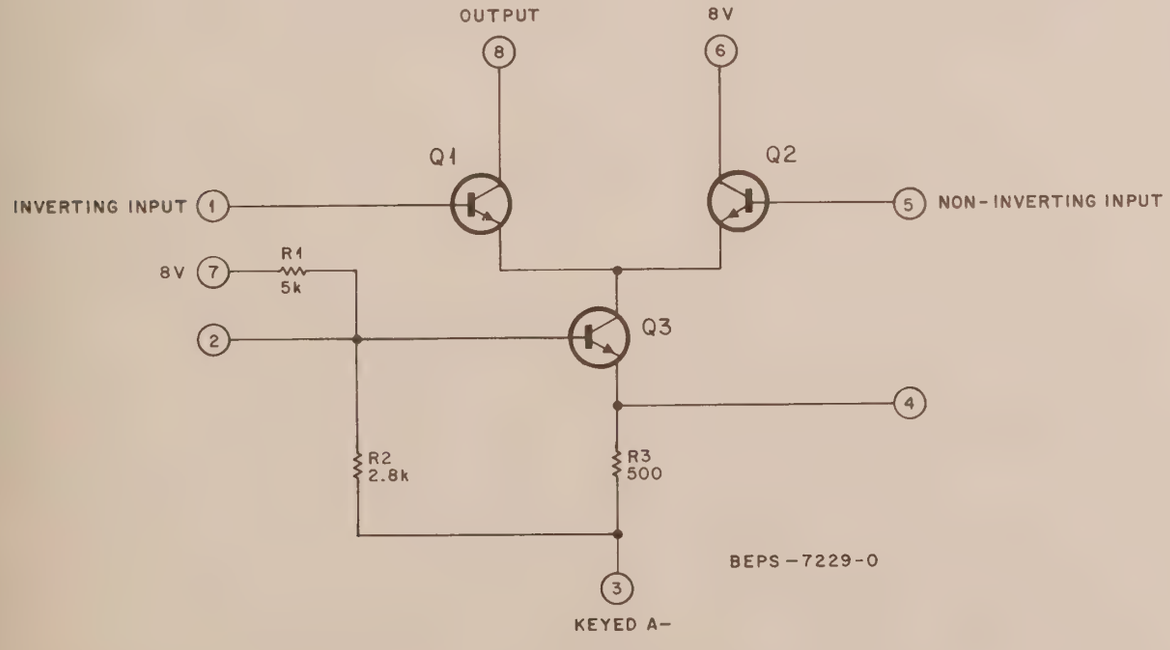


Figure 3.
IC601 Schematic Diagram

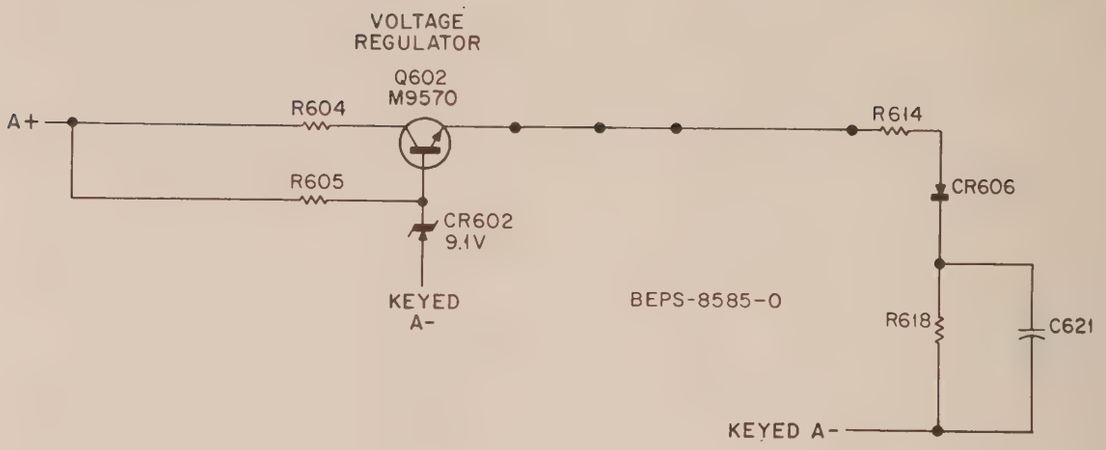


Figure 4.
Voltage Regulator and Main Divider Line

normal operating conditions (1:1 VSWR; 100% rated power out and normal heat sink temperature on intermittent duty stations) the bias on the differential amplifier inputs are developed as described in the following paragraphs.

(1) Voltage Regulator and Main Divider Line

Refer to Figure 4. The A+ supply to the board is regulated by a series regulator circuit providing a nominal voltage of 8.0 volts. The Zener diode holds the base of the series pass transistor at a fixed potential. The series pass transistor operates as a variable resistor to hold the input to the reference circuitry constant. The divider consisting of the two resistors and the diode provides the proper voltage tap points for the secondary voltage divider networks. All 220 pF capacitors in the board are used as rf bypasses.

(2) Reference Bias Circuit

Refer to Figure 5. The reference bias is developed (with a 1:1 VSWR and normal heat sink temperature on intermittent duty stations) by the voltage divider made up of two resistors and a diode between the regulated supply voltage and the switched A- source. Since A+ is applied to the board continuously and A- is only applied when the transmitter is keyed by the push-to-talk

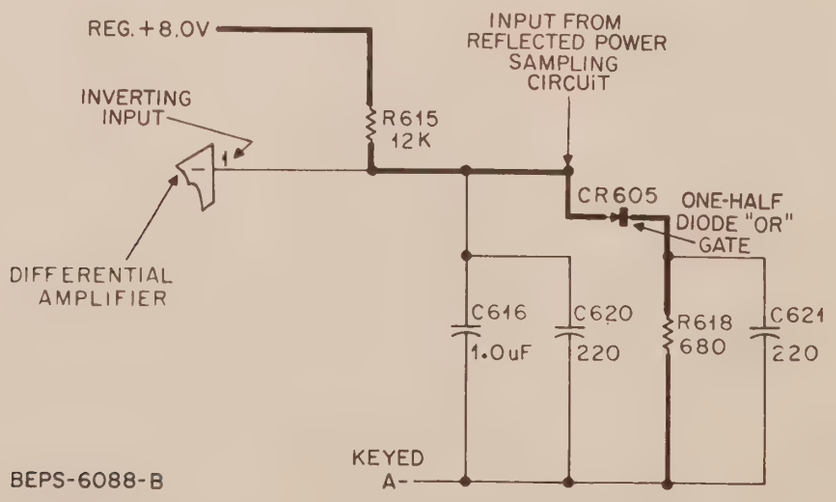


Figure 5.
Reference Power Bias Circuit

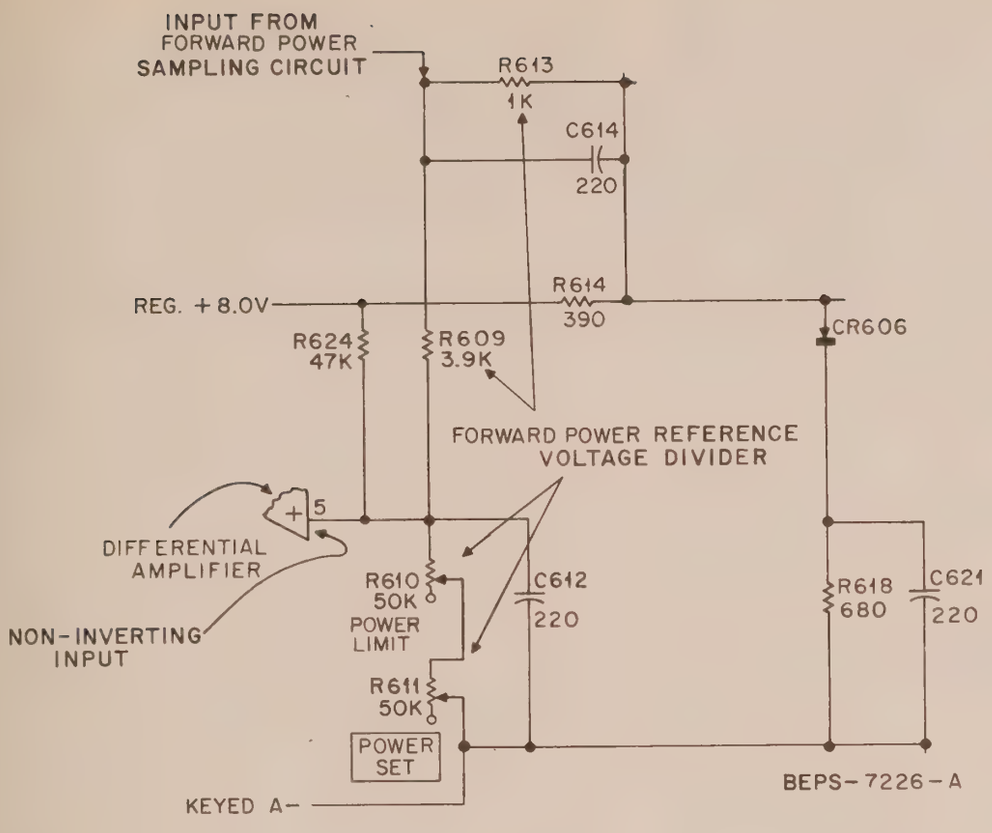


Figure 6.
Forward Power Bias Circuit

switch, the larger capacitor connected between the inverting input and keyed A- provides a time constant which allows the inverting input bias to build up slowly when power is first applied. This prevents full power output from occurring until the leveling circuitry can react and reach a quiescent level.

b. Directional Coupler

The directional coupler measures the voltage and the current traveling in both directions. The detection of forward (output) power causes a proportional voltage bias that is combined with the voltage-divider generated bias to set the potential on the non-inverting input of the differential amplifier. Any reverse power detected causes the VSWR circuitry to decrease the power output.

c. Protection Circuitry

(1) Forward Power Bias and Detection Circuit

Refer to Figure 6. The forward power reference voltage divider comprised of two resistors and two potentiometers provides a stable potential that supplies a dc bias to the non-inverting input of the differential amplifier. With an approximately correct power output from the final stages of the power amplifier, a dc level proportional to that power is produced by the forward power detector circuit, which, in combination with the voltage developed by the voltage divider, produces a bias on the non-inverting input that can be adjusted by the POWER SET potentiometer. The POWER LIMIT control is pre-set to prevent over-dissipation if the POWER SET control should be set to maximum. (Refer to the CAUTION preceding maintenance information in this section.) The dc bias value will be determined by the power amplifier output and, with no reflected power (VSWR 1:1), balanced against the reference bias present on the inverting input of the differential amplifier. Once the bias has been set, and change in power output will change the bias on the non-inverting input causing the differential amplifier to compensate for the deviation. The forward power detector circuit (refer to Figure 7) detects rf power flowing through the directional coupler when the transmitter is keyed, and causes a small proportional current flow in the forward power sampling circuit. The diode converts the rf sample into a pulsating dc voltage and the dc filter removes the ripple. This is the dc voltage which is added to the dc bias already applied to the non-inverting

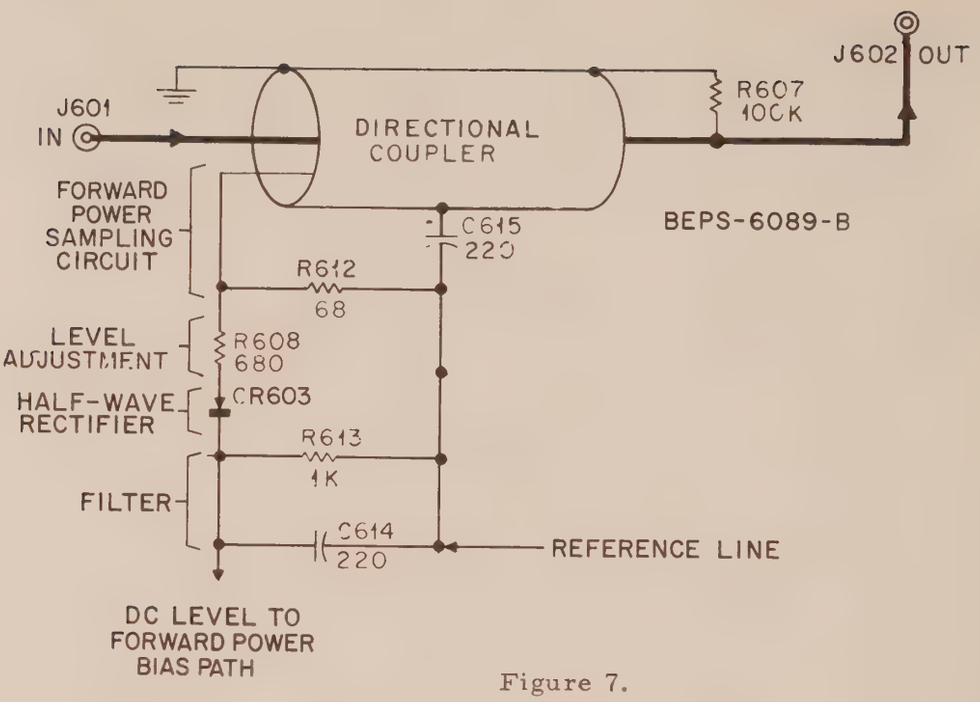


Figure 7.
Forward Power Detector Circuit

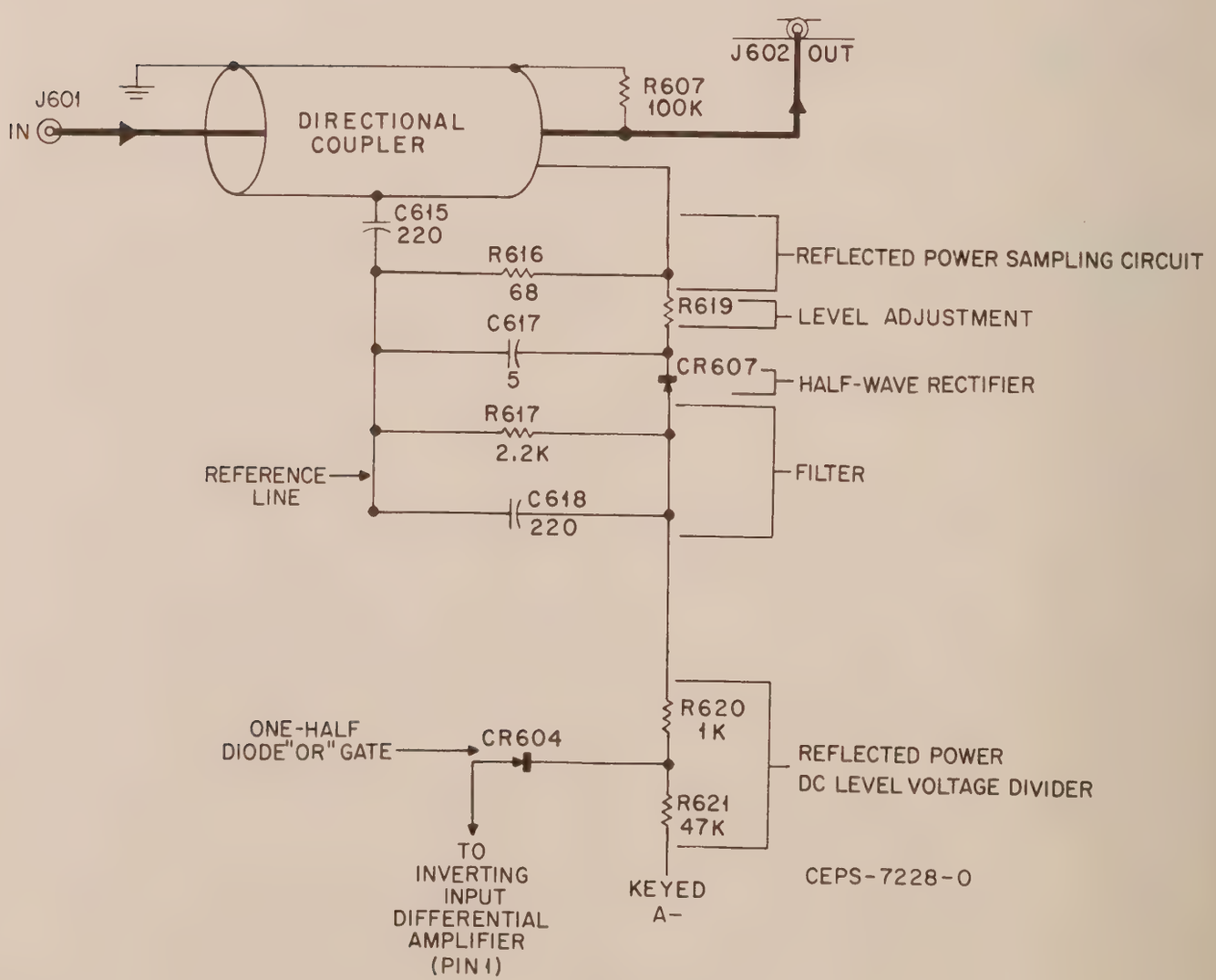


Figure 8.
Reverse Power Detector Circuit

input of the differential amplifier from the secondary divider circuitry.

(2) VSWR - Reverse Power Detection Circuit

Since the power control board is now operating correctly with the proper amount of forward power and the correct biases, the detection of reflected power causes a decrease in the power amplifier's output in the following manner.

Refer to Figure 8. The components of the reverse power detector circuit function the same as those in the forward power detector. The voltage divider develops a bias voltage that isn't quite enough to forward bias the diode that makes up one-half of a diode "OR" gate. When reflected power is detected, the resultant negative-going dc level lowers the dc bias level and the combination of the two forward bias the diode. The negative-going dc level on the inverting input increases the output voltage of the differential amplifier, decreasing the dc control output to protect the final stages of the power amplifier.

(3) Temperature Protection Circuit

Refer to Figure 9. When the heat sink temperature rises above approximately 80°C, the thermistor in parallel with the lower half of the VSWR voltage divider reaches a value of resistance which allows a more negative potential to be applied through the diode "OR" gate to the inverting input of the differential amplifier. The temperature protection decreases the level of the reference and therefore the power output of the power amplifier board.

Thermistor RT601 is omitted on continuous duty stations. Temperature protection is not needed due to the large exchanger used.

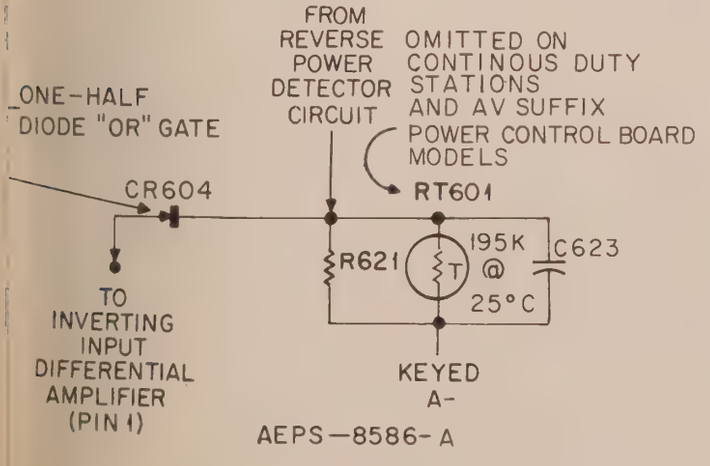


Figure 9.
Temperature Protection Circuit

(4) DC Level Output Amplification

The output of the differential amplifier is applied to the base of a voltage-inverting transistor amplifier whose output supplies the output control current. As the forward power increases above the normal value, the output of the differential amplifier increases proportionally. Since the dc level is increasing the base, the P-N-P transistor conducts less and the potentials across the output load resistor, and on the control output line, decrease.

4. MAINTENANCE

CAUTION

The power control board is incorporated in the transmitter to provide protection for the rf power transistors under environmental conditions such as voltage, temperature, load variation, and device variations. In order for the circuitry to operate properly and provide protection it is necessary to set the power output control (POWER SET) in accordance with the station alignment procedure.

a. General

Two basic maintenance approaches may be used for localizing and replacing trouble in these radio sets.

- Replace the defective circuit board with a spare and return the defective board to a maintenance shop for repair.

If necessary, a power control board from a "Micor" mobile radio may be used as a replacement. In continuous duty stations, remove thermistor RT601 before installing the board.

CAUTION

If the power control board is removed from a continuous duty station, be sure Thermistor RT601 is replaced before using the board in a mobile radio or intermittent duty station.

- Isolate and repair the trouble on the spot. This approach must be used if spares are not available.

Regardless of the maintenance approach used, a few simple tests on the overall radio set will localize the trouble to the power control board if it is defective. These procedures are given elsewhere in the manual. This section of the manual provides the maintenance shop level

procedures for the power control circuitry. It assumes that preliminary tests have already localized the trouble to the power control board. These bench test type procedures include measurements with a Motorola portable test set, a simple set of performance tests, and complete troubleshooting procedures including step-by-step circuit check-out.

NOTE

The power control board must be installed in the station for testing to provide the necessary power, ground, control, and signal connections. For bench testing of a board that has been removed from the station and replaced by a spare, another station or Motorola "Micor" ® mobile FM two-way radio is required as a test fixture for troubleshooting.

b. Recommended Test Equipment

The following test equipment is the minimum required for troubleshooting and adjusting the board. All such equipment is battery operated. When ac operated equipment is used, the ground lead must not be electrically connected to ac line ground.

(1) Optional built-in station metering or Motorola S1056B through S1059B Portable Test Set and Model TEK-37 or TEK-37A Adapter Cable. (The meter or portable test set is necessary to monitor forward and reverse power detectors.)

(2) Motorola Solid-State DC Multimeter or equivalent. A 20,000 ohm-per-volt multimeter may be used but a low impedance volt-ohm meter may not be used. This meter is used for measuring dc voltages and resistance.

(3) Motorola T1013A RF Load Resistor (Dummy Load) or equivalent.

c. Metering

The power control board is equipped with a metering receptacle which allows three major test points (forward power, reflected power and control current) to be measured. Refer to the troubleshooting charts or the schematic diagram for the correct meter indications.

When optional built-in station metering is used in continuous duty stations, only exciter output (PA input), final PA current, and final PA voltage may be checked. Refer to the alignment procedure for selector switch position functions.

(1) Using Built-In Station Metering

(a) The output of the power control board must be terminated in one of three types of loads.

--The antenna load

--A dummy load such as Motorola's T1013A RF Load Resistor.

--An RF wattmeter.

NOTE

A dummy load is preferred to the antenna to eliminate the possibility of shutback due to a defective antenna.

(b) Turn the station ON.

(c) Set the selector switch of the built-in station meter to position 1 and key the transmitter. Observe the wattmeter, or the meter reading if a dummy load is used or if the antenna is used. Unkey the transmitter. Under normal conditions at rated power out, meter 1 should read between 22 uA and 40 uA typically.

(2) Using Portable Test Set

(a) Set the function selector switch of the portable test set to the XMTR position.

(b) Set the meter reversing switch of the test set to the METER REV position.

(c) Set the REF switch to position A or B.

(d) Connect the 20-pin meter cable plug to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve battery life. The plug acts as an on-off switch completing the battery circuit.

(e) Connect the red "control" plug of the adapter cable to the control receptacle on the local or remote control circuit board. Connect the white "metering" plug of the adapter cable to the receptacle on the power control board.

(f) The output of the power control board must be terminated in one of three types of loads.

--The antenna load.

--A dummy load such as Motorola's T1013A RF Load Resistor.

--An RF wattmeter.

NOTE

A dummy load is preferred to the antenna to eliminate the possibility of shutback due to a defective antenna.

(g) Turn the station ON.

(h) Set the selector switch of the test set to position 1 and key the transmitter with the XMTR ON button on the test set. Observe the wattmeter, or the meter reading if a dummy load is used or if the antenna is used. Unkey the transmitter. Under normal conditions at rated power out, meter 1 should read between 22 uA and 40 uA typically.

d. Performance Test, Power Set Control

This control allows the power output of the radio set to be varied from zero (0) power out with the control fully counterclockwise to greater than the rated output.

CAUTION

For proper operation of the protection circuitry, it is imperative that the POWER SET control never be left in a position that exceeds rated power output.

Refer to the power amplifier tune-up procedure.

(a) Key the transmitter.

(b) Adjust the POWER SET control until the rated power output is reached.

(c) Unkey the transmitter.

e. Troubleshooting

(1) Isolating Defective Components

If built-in station meter or test set readings are abnormal or tests indicate subnormal performance, a logical troubleshooting procedure is required to isolate the defective component efficiently. The accompanying troubleshooting charts summarize these results in a logical sequence. A few voltage and resistance checks in the suspected circuit should readily isolate the defective component. Note that all circuits powered by A+ and A- are not referenced to chassis ground, but to A-. This feature allows operation from positive or negative ground power sources.

(2) Troubleshooting Integrated Circuits

Integrated circuits (IC's) are very reliable components and should not be replaced until all checks have proven definitely that the IC is the defective component. Removal of an IC is time consuming and often ruins the part. Therefore, a few extra checks before that task is attempted are worthwhile. Before replacing a bad IC, make sure that the external components in the circuit are normal. Otherwise, the conditions which caused the IC to fail initially may still be present and destroy the new IC.

A defective IC on the power control board may be located by dc voltage measurements. Measure the dc voltages at the pins of the IC, as shown in the troubleshooting charts. Refer to the troubleshooting charts or the IC601 Schematic Diagram (Figure 3.), to locate and isolate any defective component on the board.

If the IC is to be replaced, use a "desoldering" iron with a vacuum bulb to remove solder.

f. Troubleshooting Notes

The schematic diagram of the power control board contains the voltages necessary for troubleshooting. These voltages are typical for normal operating conditions at rated power out for the station. Refer to the troubleshooting charts and the schematic when troubleshooting and a defect is suspected on the power control board.

NOTES

(1) Slight variations in meter readings or power out may occur during measurements. This is normal and does not necessarily indicate any problem.

(2) With 0 reflected power (1:1 VSWR), meter 2 will read between -10 uA and -18 uA on Model TLD8610A, and between -3 uA and -8 uA on Model TLD8620A. Again, this is normal and does not indicate a defect. The meter reversing switch on the portable test set must be placed in the OFF position for upscale readings of meter 2. Built-in station metering polarity switch mube be set to FWD when metering the power control board.

g. Complete Power Amplifier Alignment

A complete realignment of the power amplifier tuning controls and power control board adjustments may be necessary under the following conditions:

(1) Major changes, repairs (such as transistor replacement) or complete replacement of the power amplifier board.

(2) Repair or replacement of the power control board.

(3) A change in transmitter frequency greater than approximately ±1 MHz.

A complete alignment procedure is at the end of this section.

IMPORTANT

The complete alignment procedure differs from the standard tune-up procedure in that a factory set control which has been adjusted for full power amplifier protection under tune-up conditions must be readjusted. This complete alignment procedure is not required and should not be performed when an alignment check is required or if frequency has been changed less than ±1 MHz.

(CONT'D)

CONT'D)

If the trans
the exciter

STEP	ADJUST	METE PLU LOCA	& METER / SWITCH SITION E NOTE)	STAGE
1			ER REV A	TRANSM Adjust R the statio output is ther incr is observ adjust the control fo 5- to 10-
			ER REV B	PA DRIV C501 for reading. minimum at maxim 90/100/1 C501, the mum met
2	C501 C502 R610		ER REV A	TRANSM Adjust R power out approxim 110-watt ly 115 W. NOTE: If cannot be steps 5 a
			ER REV B	Replace t board shi exceeds 5 is replace and adjus knob towa the statio reading-- obtained placed. should be fied in st
			ER REV A	TRANSM Adjust the trol for r repeat st
3	POWER SET	POWE CONT BOARI	ER REV B	FINAL C CURREN ing plug t the final (I$_C$). I$_C$, meter 5 r for 60-wa reading (90/100/1
4	C501	POWE CONT BOARI		

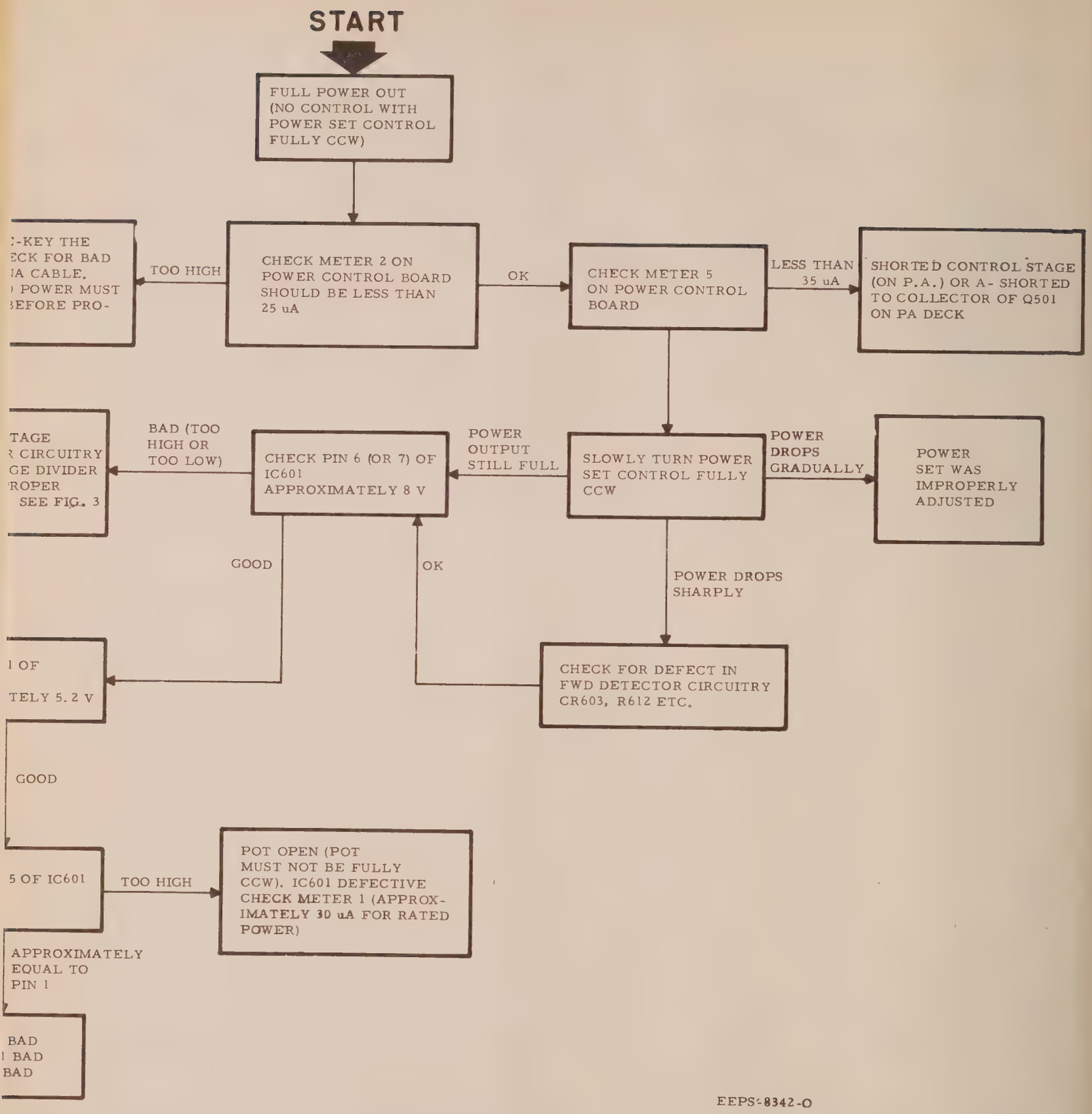
METER WITCH TION NOTE)	STAGE AND PROCEDURE
REV.	FINAL COLLECTOR VOLTAGE - Measure the final collector voltage (V_c). V_c is the meter 6 reading (0-30 V scale).
	Determine the final input power (P_{in}). P_{in} equals $V_c \times I_c$. P_{in} should be less than: 120 W for 60 W models 180 W for 90 W models 200 W for 100 W and 110 W models

METERING

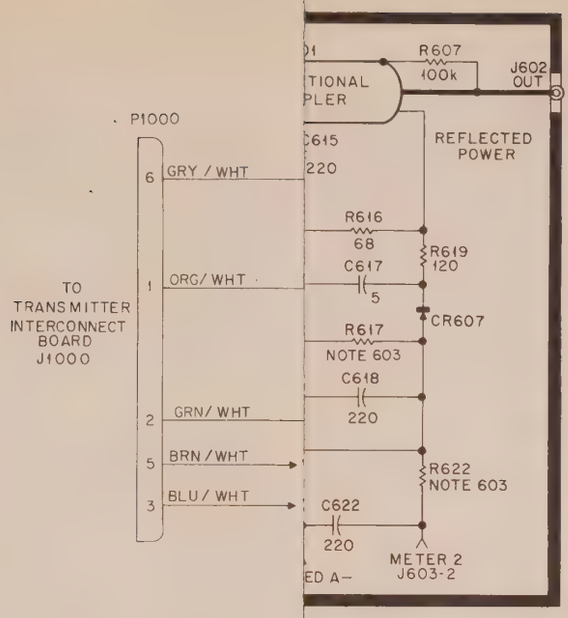
proper 50 ohm load.

NGS	FUNCTION
	Indicates forward power output per calibration label on PA shield.
dels) 0/	A meter reading higher than the normal range indicates reflected power caused by a defective antenna, antenna switch, or cables.
	Indicates the relative level of drive sent to the PA on the blue control lead. A reading of greater than 35 uA indicates the power control board is set for a higher power than the radio is capable of supplying.

S1056B thru S1059B
metering. The OSC.
rtable test set usage.
ar to the portable
e two voltage probes.
REV for PA metering


START
FULL POWER OUT (NO CONTROL WITH POWER SET CONTROL FULLY CCW)
CHECK METER 2 ON POWER CONTROL BOARD SHOULD BE LESS THAN 25 uA
TOO HIGH
OK
CHECK METER 5 ON POWER CONTROL BOARD
LESS THAN 35 uA
SHORTED CONTROL STAGE (ON P.A.) OR A- SHORTED TO COLLECTOR OF Q501 ON PA DECK
SLOWLY TURN POWER SET CONTROL FULLY CCW
POWER OUTPUT STILL FULL
POWER DROPS GRADUALLY
POWER SET WAS IMPROPERLY ADJUSTED
CHECK PIN 6 (OR 7) OF IC601 APPROXIMATELY 8 V
BAD (TOO HIGH OR TOO LOW)
GOOD
OK
POWER DROPS SHARPLY
CHECK FOR DEFECT IN FWD DETECTOR CIRCUITRY CR603, R612 ETC.
GOOD
TOO HIGH
POT OPEN (POT MUST NOT BE FULLY CCW). IC601 DEFECTIVE CHECK METER 1 (APPROX-IMATELY 30 uA FOR RATED POWER)
APPROXIMATELY EQUAL TO PIN 1

EEPS-8342-O



POWER CONTROL BOARD

601. VOLTAGES AT PINS 1 AND 5 SHOULD DIFFER BY LESS THAN 50 mV.
602. VOLTAGES MEASURED AT 25 C.
603.

POWER	R606	R622	R617
60 W	15K	18K	1.8K
90/100/110 W	27K	47K	2.2K

604. TYPICAL VOLTAGES UNDER NORMAL OPERATING CONDITIONS.
605. UNLESS OTHERWISE STATED: CAPACITOR VALUES ARE IN PICOFARADS.
606. FACTORY ADJUSTMENT.
607. RT601 OMITTED IN CONTINUOUS DUTY STATIONS AND FOR MODELS TLD8610AV & TLD8620AV.
608. USED ONLY IN CONTINUOUS DUTY STATIONS. NOT PART OF OR MOUNTED ON POWER CONTROL BOARD. PART OF MODEL TLN4780A P.A. HEAT SINK KIT.
609. ON MODEL TLD5960A CR602 IS A HYBRID ASSEMBLY.

EPS-8313-E

PARTS LIST SHOWN ON
BACK OF THIS DIAGRAM

TLD8610A-1 and TLD8620A-1
TLD8610AV, TLD8620AV and TLN5960A
Power Control Board
Schematic Diagram and Circuit Board Detail
Motorola No. 63P81015E08-K
6/15/79-PHI

TRICAL PARTS LIST

)A Power Control Board (High Power)
)A/AV Power Control Board (Low Power)
)A/AV Power Control Board (High Power) PL-1508-F

NOTE
arts list covers more than one model. Where differences
ie model number of the applicable unit is given in the
ption column.

		CAPACITOR, fixed:
	21-83596E10	220 pF ±20%; 500 V
	21-83596E10	220 pF ±20%; 500 V
aru 608	21-83596E10	220 pF ±20%; 500 V
	21-82372C04	.05 uF +80-20%; 25 V
-12	21-83596E10	220 pF ±20%; 500 V
-15	21-83596E10	220 pF ±20%; 500 V
	23-83214C04	1.0 uF ±20%; 15 V
	21-82133G53	5 pF ±0.5 pF; 500 V; NP0
aru 624	21-83596E10	220 pF ±20%; 500 V
	21-82187E14	.001 uF ±10%; 100 V
		SEMICONDUCTOR DEVICE, diode:
	48-83654H01	silicon
	48-83696E04	Zener (9.1 V)
	or 1-80709D68	hybrid assembly
	48-84616A01	silicon
	48-82392B18	silicon
	48-82392B18	silicon
	48-82392B18	silicon
	48-84616A01	silicon
	48-82392B03	silicon
	48-82392B18	silicon
		COUPLER, line:
	58-84685B01	dual
		INTEGRATED CIRCUIT:
	51-84320A02	M2002
		CONNECTOR, receptacle:
	28-84227B02	male; single contact
	9-84231B02	female; single contact
	9-84207B01	female; 7 contact
		COIL, RF:
	76-83960B01	ferrite bead
	24-83961B01	choke
	76-83960B01	ferrite bead
	—	CONNECTOR, plug: consists of: (TLD8610AV & TLD8620AV only)
	15-83498F06	HOUSING, connector
	29-83499F01	CONTACT, terminal: 5 used
	46-84549F01	PLUG, polarizing
		TRANSISTOR:
	48-869641	PNP; type M9641
	48-869570	NPN; type M9570
		RESISTOR, fixed: ±10%; 1/4 W: unless otherwise stated
	17-82291B21	100 ±5%; 3 W
	6-124C49	1k
	6-124C19	56
	6-124A45	680 ±5%
	6-124A77	15k ±5% (TLD8610A only)
	or 6-124A83	27k ±5% (TLD8620A, TLD5960A)
	6-124C97	100k
	6-124A45	680 ±5%
	6-124A63	3.9k ±5%
	18-83083G26	variable; 50k
	18-83083G20	variable; 50k
	6-124A21	68 ±5%
	6-124A49	1k ±5%
	6-124A39	390 ±5%
	6-124C75	12k
	6-124A21	68 ±5%
	6-124A57	2.2k ±5% (TLD8620A, TLD5960A)
	or 6-124A55	1.8k ±5% (TLD8610A only)
	6-124A45	680 ±5%
	6-124A27	120 ±5%
	6-124C49	1k
	6-124A89	47k
	6-131526	18k ±5% (TLD8610A only)
	or 6-124A89	47k ±5% (TLD8620A, TLD5960A)
	6-185A93	68k ±5%; 1/8 W
	6-185B99	47k; 1/8 W

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R625	6-185A73	10k ±5%; 1/8 W
RT601	6-82462G03	THERMISTOR: 195k @25°C (TLD8610A & TLD8620A only)
	MECHANICAL PARTS	
	3-139506	SCREW, tapping 4-40 x 5/16"; 4 used
	42-84284B01	RETAINER; 4 used
	55-84300B04	HANDLE

Power Amplifier Heatsink Kit (P/O TLN4780A) PL-2657-A

C780	23-83214C20	CAPACITOR, fixed: 10 uF ±20%; 20 V
L780	24-80900A61	COIL, RF: choke; 0.62 mH; coded BRN-ORG
R780	6-124B67	RESISTOR, fixed: 8.2 ±5%; 1/4 W

STATION DATA

Description 68P81041E74
Installation 68P81042E41
System Audio Level Adjustments 68P81060E24
Station Maintenance 68P81042E51

TRANSMITTER

Transmitter Introduction 68P81042E88
Transmitter Interconnect Board 68P81041E44
Exciter 68P81026E66
Power Amplifier 68P81039E38
Power Control Board 68P81015E07

RECEIVER

Receiver Introduction 68P81042E89
Receiver Interconnect Board 68P81034E07
RF & I-F Board 68P81026E37
Audio & Squelch Board 68P81025E79
Audio & Power Amplifier 68P81014E97

POWER SUPPLIES

Power Supply 68P81020E44
Power Supply 68P81041E49

MISCELLANEOUS

RF Wattmeter 68P81041E76
F0 Kit 68P81042E12
Power Coupler 68P81042E11

REMOTE CHASSIS AND MODULES

Remote Control Chassis 68P81041E51
Line Driver 68P81041E48
Station Control 68P81041E39
Pilot Tone Decoder 68P81041E41
Tone Function Decoder 68P81041E42
Encoder 68P81036E36
DC Function Decoder 68P81041E43
RQS Detector 68P81041E18
RQS Line Current Generator 68P81041E17
Metering Module 68P81041E38
Sub-Audible Paging 68P81044E56

. GENERAL

The receiver used in this station accepts signals in he 150.8 to 160 MHz range. A plug-in crystal oscillator nit (channel element) provides stable frequency control t the selected frequency of operation.

NOTE
The VHF PULSAR™ IMTS Base Station operates on a single frequency, determined by the channel element selected.

The following sections contain descriptions of the ndividual components that make up the VHF receiver h this station. Also included in each section is alignnent and maintenance procedural information for the quipment.

NOTE
Each station is equipped with a metering module to facilitate adjustments and troubleshooting of the equipment. If desired, a portable test set may be used to obtain meter readings, however, it cannot be used for keying or modulating the transmitter.

I. DESCRIPTION

The following items make-up the receiver of this tation.

.1 RF AND I-F BOARD

The fully solid-state receiver rf & i-f circuitry is sed to develop a low-noise audio signal from a freuency modulated "on-channel" rf carrier in the 32-174 MHz range.

2.2 AUDIO & SQUELCH AND AUDIO POWER AMPLIFIER

This circuitry provides the voice audio in the 300-3000 Hz range, with up to 10 watts of audio power developed at less than 5% distortion. When no messages are being received, the squelch circuit turns off the audio amplifiers to eliminate annoying noise in the speaker. A squelch tail eliminator circuit prevents the noise burst at the end of a message for strong signals. For weak signals, the circuit is automatically inhibited to prevent loss of portions of messages.

The receiver volume and squelch controls are located on the receiver chassis. The receiver volume control will only affect local speaker operation, while the receiver squelch control affects both local and remote operation.

All circuits are constructed on a single plug-in circuit board which is easily removed and replaced. All external dc and audio connections are made at a single row of pins which eliminate interconnecting wires; rf input is provided by a single plug-in coaxial cable. Circuit board plating is on both sides of the board with all components mounted on the back side. All alignment points are accessible from the front of the station.

NOTE
This station does not make use of "AND-SQUELCH" "Private-Line" or "Digital Private-Line" in its operation.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

UNIFIED CHASSIS RECEIVER INTERCONNECT BOARD

1. DESCRIPTION

The receiver interconnect board connects the receiver rf and i-f board and the receiver audio and squelch board to the station unified chassis interconnect board.

A number of jumpers are provided to allow use of the board in single and two-receiver stations, with "Digital PL" operation and for modified squelch operations. Jumper connections for these modes of operation are shown in the jumper chart on the receiver interconnect board schematic diagram.

2. "AND SQUELCH" OPERATION

An optional mode of receiver operation, known as "AND SQUELCH", can be added when desired. This feature provides "variable PL sensitivity" (coded squelch plus adjustable noise-activated carrier squelch.)

In this mode, the receiver audio channel is activated when a PL tone is received and the carrier squelch threshold level is exceeded. Since the carrier (noise-activated) squelch circuit sensitivity is adjustable, and since it is one of the controlling factors in the squelching of receiver audio, the operation can be aptly described as "variable PL sensitivity". Thus, "AND SQUELCH" denotes both coded squelch and carrier squelch operating simultaneously.

Conversion of the receiver to the "AND SQUELCH" mode of operation requires the addition of certain components to the receiver interconnect board, and the omission of certain jumpers on both the receiver interconnect board and the audio & squelch board.

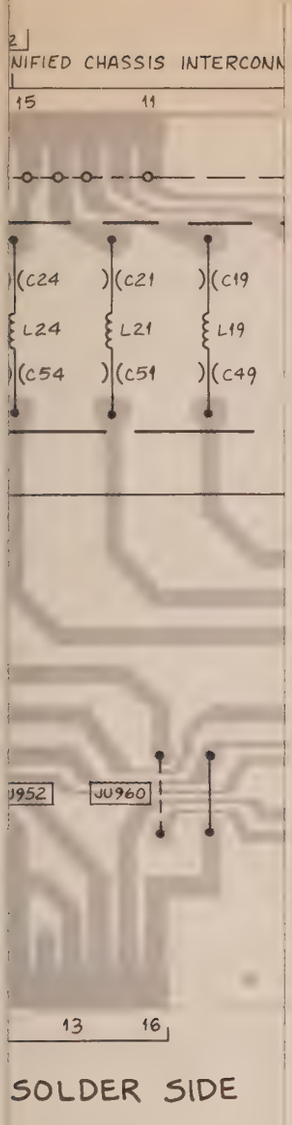
The parts required to convert the receiver to "AND SQUELCH" operation are listed with the receiver interconnect board schematic diagram.

Refer to the Audio & Squelch Board section (68P81025E79) of this manual for further details relating to "AND SQUELCH" operation.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

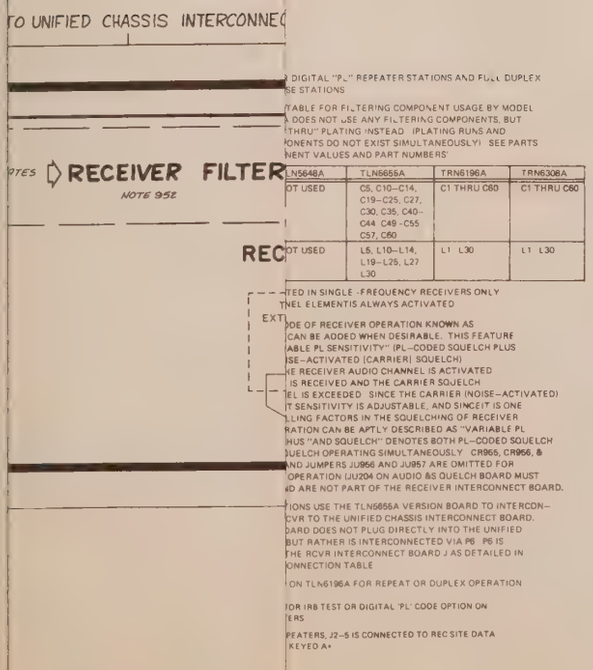
RECEIVER INTERCONNECT BOARD



FUNCTION

— Interconnects various receiver circuit boards to the unified chassis interconnect board. Model differences are primarily rf filtering.

MODEL	APPLICATION
TLN5646A	With Repeater Stations
TLN5648A	With Base Stations (1st RCVR only)
TLN5655A	With Base Stations (2nd RCVR only)
TRN6196A (optional)	In place of TLN5646A or TLN5648A (provides additional filtering)
TRN6308A (optional)	In place of TLN5655A (provides additional filtering)



DIGITAL "PL" REPEATER STATIONS AND FULL DUPLEX
SE STATIONS

TABLE FOR FILTERING COMPONENT USAGE BY MODEL
A DOES NOT USE ANY FILTERING COMPONENTS, BUT
THRU" PLATING INSTEAD (PLATING RUNS AND
ONENTS DO NOT EXIST SIMULTANEOUSLY) SEE PARTS
NENT VALUES AND PART NUMBERS'

N5648A	TLN5655A	TRN6196A	TRN6308A
OT USED	C5, C10–C14, C19–C25, C27, C30, C35, C40–C44, C49–C55 C57, C60	C1 THRU C60	C1 THRU C60
OT USED	L5, L10–L14, L19–L25, L27 L30	L1 L30	L1 L30

TED IN SINGLE-FREQUENCY RECEIVERS ONLY
NEL ELEMENTIS ALWAYS ACTIVATED

ODE OF RECEIVER OPERATION KNOWN AS
CAN BE ADDED WHEN DESIRABLE. THIS FEATURE
ABLE PL SENSITIVITY" (PL–CODED SQUELCH PLUS
SE–ACTIVATED (CARRIER) SQUELCH)
HE RECEIVER AUDIO CHANNEL IS ACTIVATED
IS RECEIVED AND THE CARRIER SQUELCH
EL IS EXCEEDED SINCE THE CARRIER (NOISE–ACTIVATED)
T SENSITIVITY IS ADJUSTABLE, AND SINCE IT IS ONE
LLING FACTORS IN THE SQUELCHING OF RECEIVER
RATION CAN BE APTLY DESCRIBED AS "VARIABLE PL
HUS "AND SQUELCH" DENOTES BOTH PL–CODED SQUELCH
QUELCH OPERATING SIMULTANEOUSLY CR955, CR956, &
ND JUMPERS JU956 AND JU957 ARE OMITTED FOR
OPERATION (JU204 ON AUDIO BD SQUELCH BOARD MUST
D ARE NOT PART OF THE RECEIVER INTERCONNECT BOARD.

IONS USE THE TLN5655A VERSION BOARD TO INTERCON–
CVR TO THE UNIFIED CHASSIS INTERCONNECT BOARD.
OARD DOES NOT PLUG DIRECTLY INTO THE UNIFIED
BUT RATHER IS INTERCONNECTED VIA P6 P6 IS
HE RCVR INTERCONNECT BOARD J AS DETAILED IN
ONNECTION TABLE

ON TLN6196A FOR REPEAT OR DUPLEX OPERATION

OR IRB TEST OR DIGITAL 'PL' CODE OPTION ON
ERS

PEATERS, J2–5 IS CONNECTED TO REC SITE DATA
KEYED A+

PARTS LIST SHOWN ON BACK
Motorola No. PEPS-28297-O
4/15/79-PHI

"MICOR" "SENSITRON" HIGH BAND RECEIVER RF & IF BOARD

TLD8270B SERIES

MODEL TABLE

MODEL	FREQUENCY RANGE (MHz)
TLD8271B	132-142
TLD8272B	142-150.8
TLD8273B	150.8-162
TLD8274B	162-174

TECHNICAL CHARACTERISTICS

INPUT IMPEDANCE		50 ohms
RF FREQUENCY RANGE		132-174 MHz
CHANNEL ELEMENT FREQUENCY RANGE		15.455-18.055 MHz
CHANNEL SPACING		30 kHz
NUMBER OF CHANNELS		1 (capable of up to 4 for special applications)
SELECTIVITY EIA SINAD		-100 dB @±30 kHz
INTERMODULATION EIA SINAD		-80 dB
MODULATION ACCEPTANCE EIA		±7 kHz
SENSITIVITY (50 OHMS RF INPUT IMPEDANCE)	20 dB Quieting	less than 0.5 microvolt
	EIA Sinad	less than 0.35 microvolt
OSCILLATOR (CHANNEL ELEMENT) STABILITY		±.0005% (AFC optional) from -30°C to +60° C ambient
SPURIOUS & IMAGE REJECTION		-100 dB
POWER REQUIREMENTS		regulated 9.6 volts @ 70 mA 13.8 volts @ 20 mA
CONSTRUCTION		fully solid-state, two integrated circuits
RECEIVER TYPE		FM superheterodyne single conversion
IF FREQUENCY		11.7 MHz or 11.8 MHz
CRYSTAL FILTER TYPE		dual resonator, mode coupled, monolithic crystal
DISCRIMINATOR TYPE		dual resonator, mode coupled, monolithic crystal
METERING		three test points critical to operation and alignment are accessible at a metering receptacle which permits testing with a Motorola portable test set, optional built-in metering, or any 50 microampere meter.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

68P81026E37-K
6/12/81-

1. DESCRIPTION

1.1 The fully solid-state receivers rf & i-f circuit board which is used for both base station and "Spectra TAC" applications, consist of an rf preselector, two integrated circuits, three transistors, two i-f crystal filters, plug-in channel elements, and a crystal discriminator. These components are used to develop a low-noise audio siganl from a frequency modulated "on-channel" rf carrier in the 132-174 MHz range.

1.2 All circuits are constructed on a single plug-in circuit board which is easily removed and replaced. All external dc and audio connections are made at a single row of pins which eliminate interconnecting wires; rf input is provided by a single plug-in coaxial cable. Circuit board plating is on both sides of the board with all components mounted on the back side. All alignment points are accessible from the front of the station.

2. FUNCTIONAL OPERATION

This circuit board is a highly selective, crystal controlled, single conversion FM receiver (less audio amplifier, squelch circuitry, and speaker). Bandwidth and selectivity characteristics are determined by rf preselector coils and i-f crystal filters. Plug-in crystal oscillator modules (channel elements) provide stable frequency control. Integrated circuits are used for all amplification and limiting after the first crystal filter section which produce high i-f signal gain and exceptionally high reliability. A crystal discriminator is used to provide high audio recovery from the i-f signal. Refer to schematic diagram for more circuit details.

3. MAINTENANCE

3.1 GENERAL

This section of the manual provides the maintenance procedures for the receiver rf and i-f section of the receiver. These bench tests include metering measurements and procedures for testing and troubleshooting, including integrated circuit check-out.

NOTE

The receiver rf and i-f board must be installed in the receiver for testing to provide the necessary power, ground, control and signal connections. The board should always be secured in place with all mounting screws for operation and testing to provide a good rf ground to all stages of the receiver. The board may be installed in the station or a "Micor" mobile radio set for testing.

3.2 "SPECTRA TAC" 20 DB QUIETING SENSITIVITY TEST

This performance test may be used after repair and alignment to assure that the receiver meets all specifications before it is returned to service.

It may be performed using a Motorola S-1056B thru S-1059B Portable Test Set or optional built-in receiver metering. J101 can accommodate only the built-in metering set or the portable test set, but not both simultaneously. Plugging a portable test set in a receiver that has built-in metering will disconnect the built-in metering cable.

NOTE

The receiver shield must be in place while performing this test.

3.2.1 Using the Portable Test Set and an AC Voltmeter

Step 1. The receiver rf and i-f board must be installed in a complete receiver for testing. Make sure the rf and i-f circuit board mounting screws are all secure and that all connections to the board are properly made.

Step 2. Be sure the receiver shield is in place.

Step 3. Apply ac input power to the receiver.

Step 4. Using a TEK-37A Adapter Cable, connect a Motorola portable test set or meter panel to the station as follows:

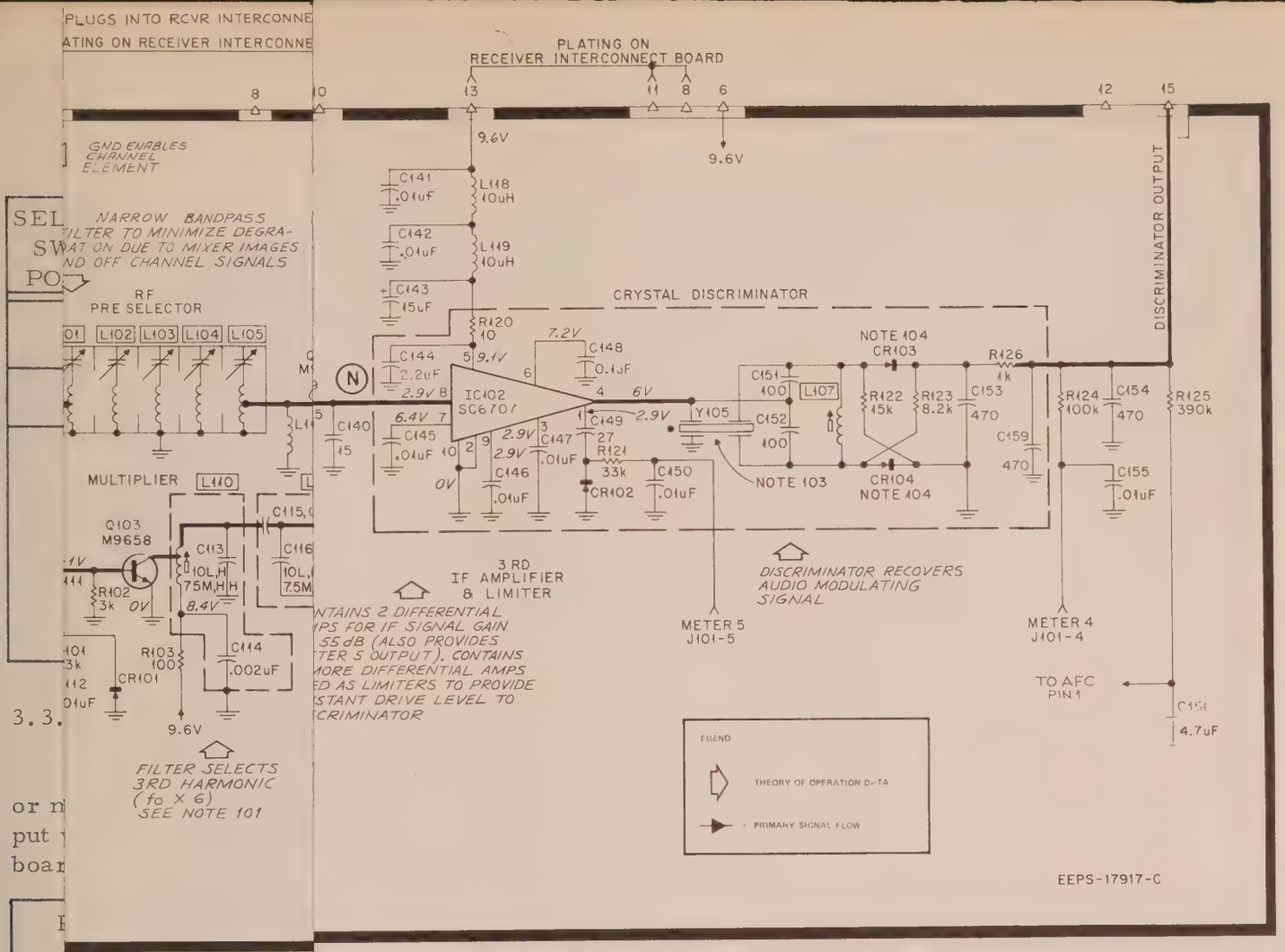
--Connect the adapter cable 20-pin connector to the receptacle on the front of the test set or meter panel.

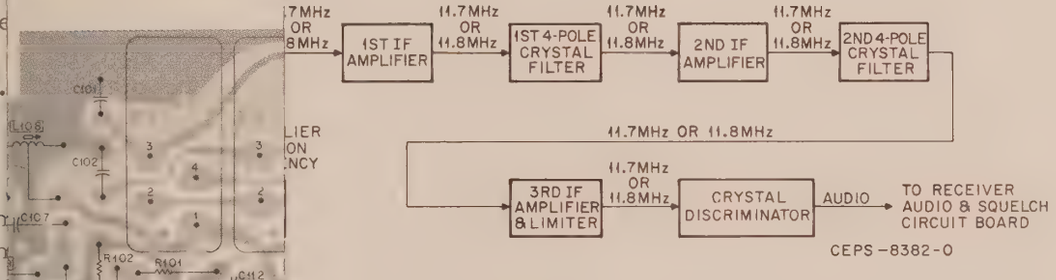
--Connect the adapter cable 7-pin white "metering" plug to the metering receptacle on the receiver rf and i-f board.

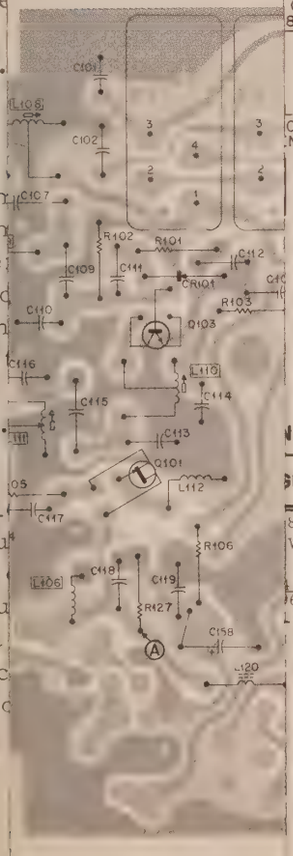
Step 5. Set the portable test set switches as follows:

--Set the function switch to the RCVR position.

--Set the meter reversing switch to the OFF position.





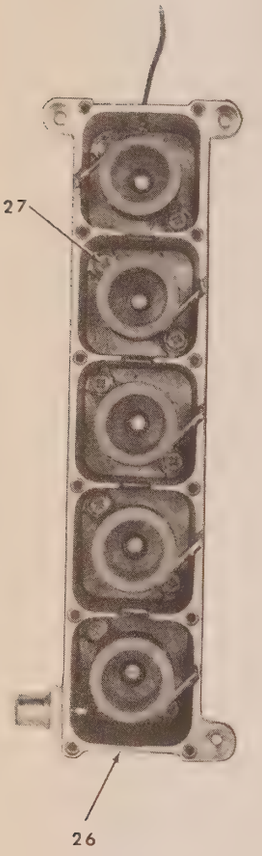


PEPS-17915-C

	LOCATION
	IC102, PIN 8
	MIXER

PARTS LIST SHOWN ON
BACK OF THIS DIAGRAM

Receiver RF & I-F Board
Schematic Diagram, Circuit Board Detail
and Block Diagram
Motorola No. PEPS-17915-C
6/15/79-PHI


27
26

"MICOR" "SENSITRON" RECEIVER AUDIO & SQUELCH BOARD

MODEL TRN6006A, AV, 7A

1. DESCRIPTION

The audio and squelch board performs two basic functions -- audio amplification and audio squelching. The first two stages in the audio circuitry amplify the signal from the discriminator and provide the proper frequency response. This signal is routed to the line driver module in remote control stations and to the local logic board in local control models. The audio returns through a VOLUME control. The remaining stages in the audio circuitry take the signal returning from the line driver and VOLUME control and provide the necessary frequency response at the speaker. These latter stages also provide the drive required by the final audio amplifiers (located on a separate board) for rated power output. An integrated circuit and one transistor perform all of these functions.

The squelch circuitry disables the audio path during intervals between received messages. One integrated circuit performs the necessary detection and squelching functions. Also, in conjunction with the PL decoder and filter board in a PL station, this integrated circuit provides unsquelching when PL signals are received.

2. FUNCTIONAL OPERATION

2.1 GENERAL

The audio signal from the receiver discriminator is routed to the emitter follower (refer to Figure 1). The emitter follower output is coupled to the SQUELCH control mounted on the receiver chassis or local front panel and also to the line level potentiometer mounted on the audio & squelch board. The signal from this control is next applied to the preamplifier. If JU201 is cut, the signal is first sent through the PL filter for attenuation of the PL tone. The preamplifier output is coupled off the board to the line driver or local logic board. Audio returning from the line driver or local logic board is coupled through the appropriate VOLUME control to amplifier Q203. After amplification, the signal is applied to the audio amplification circuits. Here, the signal is raised to a level sufficient to drive the audio power amplifiers. These are mounted on a separate board which is secured to the chassis to provide "heat-sinking" capability. The output of the audio power amplifiers is applied to an output transformer which drives a speaker or speaker desk set transformer (local control stations only).

The signal returned from the SQUELCH control is applied to the squelch section for noise squelch control. Squelch action is achieved by utilizing the inherent characteristics of a discriminator known as "noise quieting". An input signal will cause more quieting of noise as the signal level is increased. When a desired level of noise quieting is reached, as determined by the squelch circuitry and the setting of the SQUELCH control, the audio portion of the board and line driver are enabled to allow a message to be heard. In a remote control station, the squelch circuit disables the audio circuitry by shunting a point in the audio signal path to ground and also operating a series switch in the audio signal path of the line driver.

In a local control station, the series path is broken on the local logic board. In addition, an *extra* shunt switch is activated on this board and its low resistance is directed back to the audio amplification circuits. This provides extremely quiet operation during periods of no signal.

Upon completion of a received message, audio shut-off is either immediate or automatically delayed 150 milliseconds, depending upon the signal level of the previously received rf carrier. A strong signal produces the immediate shut-off and prevents an annoying, loud "squelch tail" burst from being heard. Weak signals (signals that produce less than 20 dB noise quieting) produce the long shut-off delay and prevent a message from being chopped under "flutter" conditions. Since the

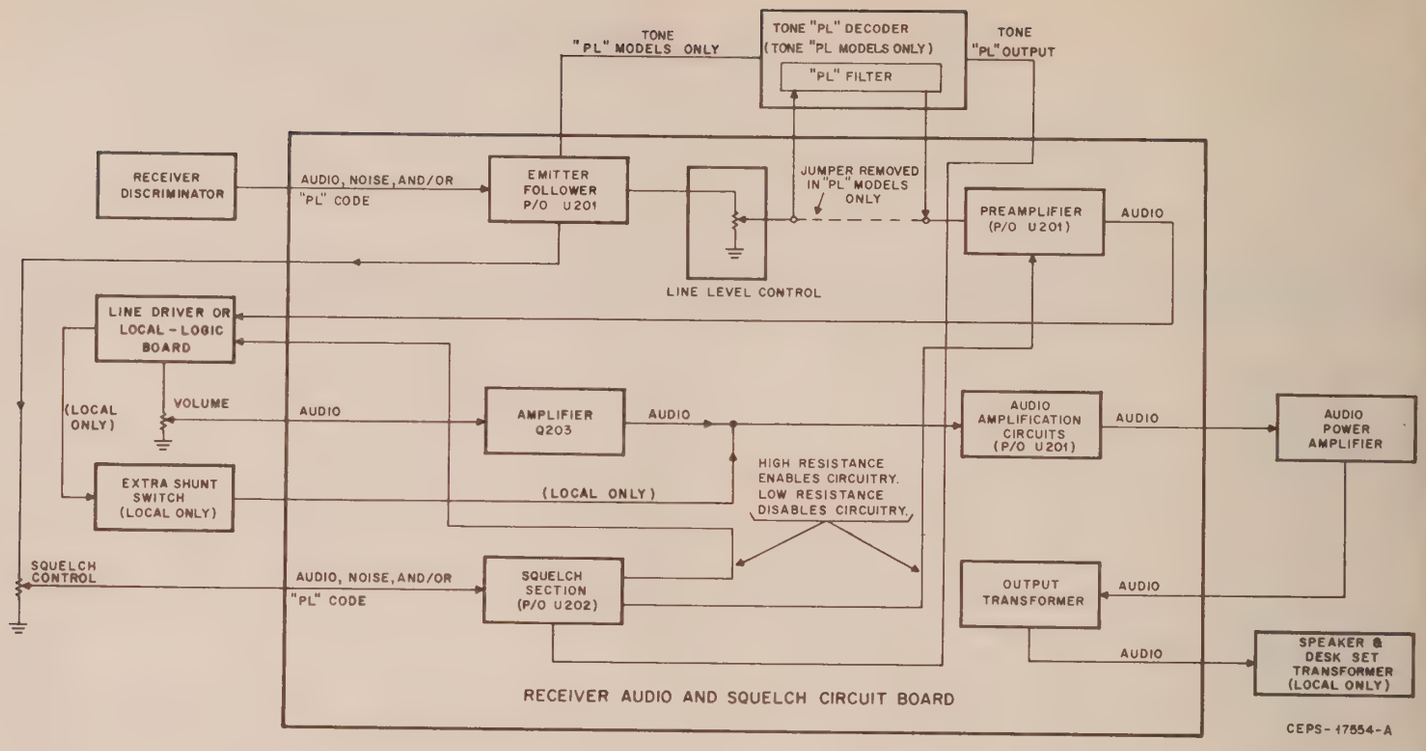


Figure 1. Audio and Squelch Block Diagram

received signal level must be low for the long turn-off delay to occur and the "squelch tail" level is comparable to that of the received signal, the "squelch tail" is not annoying.

2.2 EMITTER FOLLOWER CIRCUIT

The emitter follower circuit provides a low impedance output which isolates the high impedance discriminator output from the following squelch and audio circuitry.

The output of the discriminator is capacitively coupled to the emitter follower input at U201-1 and may consist of noise and audio signals. The output of the emitter follower at U201-2 is routed through C207 to the SQUELCH control and also to the line level control.

2.3 PREAMPLIFIER CIRCUIT

This circuit amplifies the low-level audio signal to provide the drive necessary for proper line driver operation. In addition, a negative feedback network (C208 and C209) provides the necessary frequency response characteristics for phone line operation. In PL stations, jumper JU202 is cut and the negative feedback is provided by C209 only. The network of R210 and C210 provides additional frequency response shaping.

2.4 AMPLIFIER CIRCUIT

Transistor Q203 increases the signal level from the line driver or local logic board to the level required by the audio amplification circuits. Jumper JU203 is out when the equipment leaves the factory. The gain of Q203 is sufficient to drive the audio amplification circuits if the signal strength from the line driver or squelch gate exceeds -10 dBm. With a signal strength below this level, it is advisable to put in JU203 which increases the gain of Q203. The RC network at the input to this stage provides additional frequency response shaping required at the speaker.

2.5 AUDIO AMPLIFICATION CIRCUIT

The signal from amplifier Q203 is applied to the differential amplifier thorugh capacitors C211 and C213. In a local station, the extra shunt switch on the local logic board is connected to the junction of C211 and C213.

The differential amplifier output provides the drive for the complementary amplifier. Resistors R221 and R220 form a voltage divider, biasing the differential amplifier at one-half of the supply voltage. Undesirable transient voltages are eliminated by capacitor C212.

Final audio amplification, on the audio and squelch board, occurs in the complementary amplifier. These stages provide the drive for the audio power amplifiers which are mounted on a separate board. The complementary amplifier emitter resistors (R218 and R219) are not included in U201 because of their high heat dissipation requirements.

Audio returned to the audio and squelch board (from the audio power amplifiers) is applied to the output transformer primary windings. This transformer consists of four windings -- two input primaries, an output secondary, and a feedback secondary. The output secondary winding couples audio power to an external 8-ohm speaker which can be driven with up to 10 watts at less than 5% distortion. Negative feedback from the output transformer winding through C216 and across R211 gives 6 dB per octave de-emphasis (roll-off) to the audio which has been pre-emphasized 6 dB per octave in the transmitter. Below 300 Hz, feedback from R213 and across C215 increases, giving low frequency de-emphasis. Capacitor C238 rolls off the high frequency gain of the amplifier to prevent high frequency oscillation. Capacitors C223 and C224, C240, C241, and C242 are rf bypass capacitors that shunt stray rf on the audio A+ and audio A- lines to ground. In local operation, the output secondary winding couples audio power to a 16-ohm speaker and an autotransformer. This transformer will drive up to six local desk sets.

2.6 NOISE ACTIVATED SQUELCH CIRCUIT

2.6.1 Squelch Input Circuit

The input signal from the SQUELCH control may consist of audio and noise. An input shaping network precedes U202 and passes high frequencies while attenuating low frequencies. Allowing the high frequencies to pass eliminates the effect of voice and results in more sensitive threshold squelch action.

The first amplifier and limiter is driven into limit by its input signal and prevents audio from squelching (disabling) the audio channel on voice signals. Amplified, limited noise is then passed through a coupling network to the second amplifier. This coupling network is also a high pass filter which further attenuates voice and tone signals to the second amplifier.

The second amplifier amplifies the noise signal and applies it through an RC coupling network to the detector. Capacitor C233 and C234 form another high pass filter that further attenuates the low frequencies. Capacitor C234 is used to produce a peak-to-peak detector action from the noise detector, and thus, generate twice the output voltage of a peak detector. This capacitor does not affect frequency response.

2.6.2 Detector and Switching Circuits

The detector output level is a function of received signal strength and the setting of the SQUELCH control. The detector develops the dc output voltage across filter capacitor C235. The lowest dc output voltage corresponds to a no signal input (maximum noise) condition. The output voltage increases as the received rf carrier signal level increases (noise decreases).

The primary function of the detector output, however, is the control of shunt switching. This is done by applying the detector output to three squelch control circuits simultaneously:

-- long "squelch tail" circuit,
-- long "squelch tail" defeat switch,
-- carrier squelch switching logic.

With no received rf carrier signal (maximum noise condition), the long "squelch tail" circuit and long "squelch tail" defeat switch are off and the carrier squelch switching logic is on. The audio channel is subsequently disabled, unless the squelch control logic is overridden by other circuitry.

As the input signal level increases (noise decreases), the detector output voltage increases. A detector output voltage above 2.8 volts dc results in enabling of the long "squelch tail" circuit. The long "squelch tail" circuit produces a voltage at U202-12 of 5.5 volts dc; this voltage causes the carrier squelch switching logic circuit to turn off and thereby enabling the audio channel. Capacitor C236 and resistor R235 provide a rapid-rise, slow-decay time constant to the voltage applied to the carrier squelch switching logic circuit. This permits a weak signal to immediately enable the audio channel, yet delays the audio channel shut-off if the signal is in a "flutter" condition. The voltage necessary to enable the carrier squelch switching logic is approximately 3.8 volts dc.

A voltage greater than 5 volts dc at the detector output (rf carrier signal level that produces 20 dB quieting or better with the SQUELCH control set at threshold), turns the long "squelch tail" defeat switch on. This disables the long "squelch tail" circuit and the 150 millisecond delay function. Audio channel disabling now occurs immediately after the rf carrier disappears.

2.6.3 Squelch Output Circuit

The squelch control logic circuit directly controls the shunt switches.

The output of the squelch control logic circuit depends upon the output of the preceding carrier squelch switching logic circuit. With the carrier squelch switch logic circuit off, the squelch control logic circuit will turn the shunt switches off, allowing a message to be heard. If the carrier squelch switch logic is on, the squelch control logic circuit will turn the shunt switches on, disabling the audio channel, and activating the series switches in the line driver or local logic board. Capacitor C237, connected to U202-10, slows the turn-off of the shunt switches to "soften" what would otherwise be any annoyingly abrupt turn-on of the audio. This same point (U202-10) supplies a digital output voltage that can be used as an indicator that the receiver is unsquelched (audio channel enabled).

Two additional functions that may affect the squelch control logic ouput are associated with "Private-Line" operation. PL disable (U202-14) may be either shorted to ground or open. When an open is present at U202-14 (PL disabled), a received signal with or without a PL code will be heard from the speaker. When at ground potential (PL enabled), the output of the carrier squelch switching logic circuit is inhibited. When the proper PL code is received, a +9.5 volts dc from the PL decoder board to U202-8 turns the squelch control logic circuit off which turns the shunt switches off and allows a message to be heard. Jumper JU204 is normally in the circuit and is only cut when a field modification is made. The cutting of this jumper *and associated modifications on the receiver interconnect board* will provide "AND SQUELCH" operation, changing the PL squelch circuitry from fixed sensitivity operation to variable sensitivity operation. Under this mode of operation, the SQUELCH control will affect the squelch sensitivity.

Audio disabling is performed by shunting the audio circuit to ground through a low impedance path and also by the operation of a series switch in the line driver or local logic board. When the solid state shunt switch is turned on (U202-7), signals developed across R236 are shunted to ground. This prevents any signals from being heard at the speaker. Acting in tandem with the first shunt switch, the second shunt switch output is routed to the line driver or local logic board and enables a set of switches on either of the boards. In a remote control system, this breaks the audio path and prevents audio from appearing on the 600-ohm line. In a local control system, these series switches also break the audio path, thus preventing any audio or hum and noise from reaching the speaker.

3. MAINTENANCE

3.1 GENERAL

This section of the manual provides maintenance shop type procedures for the audio and squelch board. It assumes that preliminary tests have already localized the trouble to this board. These bench tests include procedures for testing and troubleshooting, including integrated circuit check-out.

NOTE

The audio and squelch board must be installed in a station for testing to provide the necessary power and ground connections.

3.2 PERFORMANCE TESTS

The performance test may be used for troubleshooting to isolate the point of abnormal operation. They may also be used after repair to assure that the board is operating properly before it is returned to service.

3.2.1 Audio Amplification

3.2.1.1 Specifications

The audio section of the audio and squelch board combined with the separate audio power amplifier transistors will provide at least 10 watts (5 wattts local) audio output at less than 5 per cent distortion from a 3.0 kHz deviated, 1 kHz modulated on-frequency signal applied to the station antenna receptacle.

3.2.1.2 Procedure

Step 1. Replace the speaker with an 8 ohm, 15 watt non-inductive resistor. In local control stations, disconnect the autotransformer.

Step 2. Set the SQUELCH control fully counterclockwise (unsquelched). "Private-Line" stations must also be PL disabled.

Step 3. Connect an rf signal generator to the station antenna receptacle and adjust it to the receiver frequency.

Step 4. Adjust the signal generator for 1000 microvolt output, modulated with 1000 Hz tone at ±5.0 kHz deviation.

Step 5. Connect an AC voltmeter to pin J903-7 at the receiver interconnect board.

Step 6. Adjust the line level control R203 for 175 mV ac rms.

Step 7. Reduce the deviation to ±3.0 kHz.

Step 8. Connect an AC voltmeter across the 8 ohm resistor.

Step 9. Adjust the VOLUME control until 9.0 volts ac rms is read on the ac voltmeter (this represents 10 watts).

Step 10. Measure distortion at 10 watts audio power output. It should be less than 5%

3.2.2 Squelch Control

3.2.2.1 Specifications

3.2.2.1.1 The squelch section of the receiver audio and squelch board shall enable the audio section when an rf signal level greater than 6 dB noise quieting (one-half the discriminator output level with no signal input) is applied to the receiver with the SQUELCH control set at threshold. When the signal is removed from the station, the audio channel shall become disabled after approximately 150 milliseconds. When an

Audio returned to the audio and squelch board (from the audio power amplifiers) is applied to the output transformer primary windings. This transformer consists of four windings -- two input primaries, an output secondary, and a feedback secondary. The output secondary winding couples audio power to an external 8-ohm speaker which can be driven with up to 10 watts at less than 5% distortion. Negative feedback from the output transformer winding through C216 and across R211 gives 6 dB per octave de-emphasis (roll-off) to the audio which has been pre-emphasized 6 dB per octave in the transmitter. Below 300 Hz, feedback from R213 and across C215 increases, giving low frequency de-emphasis. Capacitor C238 rolls off the high frequency gain of the amplifier to prevent high frequency oscillation. Capacitors C223 and C224, C240, C241, and C242 are rf bypass capacitors that shunt stray rf on the audio A+ and audio A- lines to ground. In local operation, the output secondary winding couples audio power to a 16-ohm speaker and an autotransformer. This transformer will drive up to six local desk sets.

2.6 NOISE ACTIVATED SQUELCH CIRCUIT

2.6.1 Squelch Input Circuit

The input signal from the SQUELCH control may consist of audio and noise. An input shaping network precedes U202 and passes high frequencies while attenuating low frequencies. Allowing the high frequencies to pass eliminates the effect of voice and results in more sensitive threshold squelch action.

The first amplifier and limiter is driven into limit by its input signal and prevents audio from squelching (disabling) the audio channel on voice signals. Amplified, limited noise is then passed through a coupling network to the second amplifier. This coupling network is also a high pass filter which further attenuates voice and tone signals to the second amplifier.

The second amplifier amplifies the noise signal and applies it through an RC coupling network to the detector. Capacitor C233 and C234 form another high pass filter that further attenuates the low frequencies. Capacitor C234 is used to produce a peak-to-peak detector action from the noise detector, and thus, generate twice the output voltage of a peak detector. This capacitor does not affect frequency response.

2.6.2 Detector and Switching Circuits

The detector output level is a function of received signal strength and the setting of the SQUELCH control. The detector develops the dc output voltage across filter capacitor C235. The lowest dc output voltage corresponds to a no signal input (maximum noise) condition. The output voltage increases as the received rf carrier signal level increases (noise decreases).

The primary function of the detector output, however, is the control of shunt switching. This is done by applying the detector output to three squelch control circuits simultaneously:

-- long "squelch tail" circuit,
-- long "squelch tail" defeat switch,
-- carrier squelch switching logic.

With no received rf carrier signal (maximum noise condition), the long "squelch tail" circuit and long "squelch tail" defeat switch are off and the carrier squelch switching logic is on. The audio channel is subsequently disabled, unless the squelch control logic is overridden by other circuitry.

As the input signal level increases (noise decreases), the detector output voltage increases. A detector output voltage above 2.8 volts dc results in enabling of the long "squelch tail" circuit. The long "squelch tail" circuit produces a voltage at U202-12 of 5.5 volts dc; this voltage causes the carrier squelch switching logic circuit to turn off and thereby enabling the audio channel. Capacitor C236 and resistor R235 provide a rapid-rise, slow-decay time constant to the voltage applied to the carrier squelch switching logic circuit. This permits a weak signal to immediately enable the audio channel, yet delays the audio channel shut-off if the signal is in a "flutter" condition. The voltage necessary to enable the carrier squelch switching logic is approximately 3.8 volts dc.

A voltage greater than 5 volts dc at the detector output (rf carrier signal level that produces 20 dB quieting or better with the SQUELCH control set at threshold), turns the long "squelch tail" defeat switch on. This disables the long "squelch tail" circuit and the 150 millisecond delay function. Audio channel disabling now occurs immediately after the rf carrier disappears.

2.6.3 Squelch Output Circuit

The squelch control logic circuit directly controls the shunt switches.

The output of the squelch control logic circuit depends upon the output of the preceding carrier squelch switching logic circuit. With the carrier squelch switch logic circuit off, the squelch control logic circuit will turn the shunt switches off, allowing a message to be heard. If the carrier squelch switch logic is on, the squelch control logic circuit will turn the shunt switches on, disabling the audio channel, and activating the series switches in the line driver or local logic board. Capacitor C237, connected to U202-10, slows the turn-off of the shunt switches to "soften" what would otherwise be any annoyingly abrupt turn-on of the audio. This same point (U202-10) supplies a digital output voltage that can be used as an indicator that the receiver is unsquelched (audio channel enabled).

Two additional functions that may affect the squelch control logic ouput are associated with "Private-Line" operation. PL disable (U202-14) may be either shorted to ground or open. When an open is present at U202-14 (PL disabled), a received signal with or without a PL code will be heard from the speaker. When at ground potential (PL enabled), the output of the carrier squelch switching logic circuit is inhibited. When the proper PL code is received, a +9.5 volts dc from the PL decoder board to U202-8 turns the squelch control logic circuit off which turns the shunt switches off and allows a message to be heard. Jumper JU204 is normally in the circuit and is only cut when a field modification is made. The cutting of this jumper *and associated modifications on the receiver interconnect board* will provide "AND SQUELCH" operation, changing the PL squelch circuitry from fixed sensitivity operation to variable sensitivity operation. Under this mode of operation, the SQUELCH control will affect the squelch sensitivity.

Audio disabling is performed by shunting the audio circuit to ground through a low impedance path and also by the operation of a series switch in the line driver or local logic board. When the solid state shunt switch is turned on (U202-7), signals developed across R236 are shunted to ground. This prevents any signals from being heard at the speaker. Acting in tandem with the first shunt switch, the second shunt switch output is routed to the line driver or local logic board and enables a set of switches on either of the boards. In a remote control system, this breaks the audio path and prevents audio from appearing on the 600-ohm line. In a local control system, these series switches also break the audio path, thus preventing any audio or hum and noise from reaching the speaker.

3. MAINTENANCE

3.1 GENERAL

This section of the manual provides maintenance shop type procedures for the audio and squelch board. It assumes that preliminary tests have already localized the trouble to this board. These bench tests include procedures for testing and troubleshooting, including integrated circuit check-out.

NOTE

The audio and squelch board must be installed in a station for testing to provide the necessary power and ground connections.

3.2 PERFORMANCE TESTS

The performance test may be used for troubleshooting to isolate the point of abnormal operation. They may also be used after repair to assure that the board is operating properly before it is returned to service.

3.2.1 Audio Amplification

3.2.1.1 Specifications

The audio section of the audio and squelch board combined with the separate audio power amplifier transistors will provide at least 10 watts (5 wattts local) audio output at less than 5 per cent distortion from a 3.0 kHz deviated, 1 kHz modulated on-frequency signal applied to the station antenna receptacle.

3.2.1.2 Procedure

Step 1. Replace the speaker with an 8 ohm, 15 watt non-inductive resistor. In local control stations, disconnect the autotransformer.

Step 2. Set the SQUELCH control fully counterclockwise (unsquelched). "Private-Line" stations must also be PL disabled.

Step 3. Connect an rf signal generator to the station antenna receptacle and adjust it to the receiver frequency.

Step 4. Adjust the signal generator for 1000 microvolt output, modulated with 1000 Hz tone at ±5.0 kHz deviation.

Step 5. Connect an AC voltmeter to pin J903-7 at the receiver interconnect board.

Step 6. Adjust the line level control R203 for 175 mV ac rms.

Step 7. Reduce the deviation to ±3.0 kHz.

Step 8. Connect an AC voltmeter across the 8 ohm resistor.

Step 9. Adjust the VOLUME control until 9.0 volts ac rms is read on the ac voltmeter (this represents 10 watts).

Step 10. Measure distortion at 10 watts audio power output. It should be less than 5%

3.2.2 Squelch Control

3.2.2.1 Specifications

3.2.2.1.1 The squelch section of the receiver audio and squelch board shall enable the audio section when an rf signal level greater than 6 dB noise quieting (one-half the discriminator output level with no signal input) is applied to the receiver with the SQUELCH control set at threshold. When the signal is removed from the station, the audio channel shall become disabled after approximately 150 milliseconds. When an

input signal greater than that required for approximately 20 dB noise quieting is removed from the station, the audio channel shall become disabled immediately.

3.2.2.1.2 When the SQUELCH control is turned fully clockwise (tight squelch) an input signal that produces about 20 dB noise quieting shall be required to enable the audio channel.

3.2.2.1.3 The squelch section shall inhibit audio output when no input signal is received.

3.2.2.1.4 In "Private-Line" stations, the squelch section of the receiver's audio and squelch board shall perform as described in paragraphs 3.2.2.1.1, .2, and .3 while the radio set is PL disabled.

3.2.2.1.5 In PL operation, the squelch section shall inhibit audio output when the proper PL code is not received, regardless of the input signal strength.

3.2.2.2 Procedure

3.2.2.2.1 Carrier Squelch Stations

Step 1. Turn the station on and adjust the SQUELCH control clockwise from the full counterclockwise position until the receiver just quiets (threshold squelch).

Step 2. Measure the resistance of U202-6 and -7 with reference to ground. Both pins should be less than 1000 ohms.

NOTE

Erroneous readings will be obtained in resistance measurements if the voltage between the ohmmeter probes exceeds approximately 5.0 volts dc.

Step 3. Connect a signal generator to the station antenna receptacle and adjust it to the receiver frequency. Modulate the generator output with a 1000 Hz tone at ± 3.0 kHz deviation.

Step 4. Increase the signal generator output slowly until the receiver just unsquelches. Remove the modulation from the signal generator. Unsquelching should occur at a generator output that produces 6 dB noise quieting, or less.

Step .5 Measure the resistances of U202-6 and -7 with reference to ground. Both pins should be greater than 200,000 ohms.

Step 6. Increase the signal generator output until approximately 12 dB noise quieting is obtained. Remove the rf signal from the station input either by turning off the signal generator or by using a relay in series with the signal generator output. A long "squelch tail" should occur. If a calibrated, triggered sweep oscilloscope is available for measurement, the duration of the "squelch tail" should be approximately 150 milliseconds as measured at the speaker.

Step 7. Increase the signal generator output to produce 30 dB noise quieting. Turn off the rf signal and note the "squelch tail" duration. It should be no more than a "click". The duration should be less than 10 milliseconds.

Step 8. Turn the SQUELCH control fully clockwise (tight squelch).

Step 9. Adjust the signal generator output level until the station just unsquelches. Unsquelching should occur at a generator output that produces approximately 20 dB noise quieting.

3.2.2.2.2 "Private-Line" Stations

Step 1. Disabled the PL circuitry.

Step 2. Perform previously described carrier squelch station procedure.

Step 3. Return the station to PL operation. On stations using "AND" squelch operation, also turn the SQUELCH control fully counterclockwise during this test.

Step 4. Vary generator output between minimum output and 1000 microvolt output while checking the resistances of U202-6 and -7 with reference to ground. Both resistances should remain at less than 1000 ohms.

Step 5. Modulate the on-frequency generator output with a PL code for ± 0.5 to ± 1 kHz deviation and 1000 Hz tone for ± 3.0 kHz overall deviation.

Step 6. Increase the signal generator output slowly until the receiver just unsquelches. Unsquelching should occur at a generator output that produces 6 dB quieting, or less.

3.3 TROUBLESHOOTING

3.3.1 Check Input Voltages

A malfunction in the audio and squelch operation may be due to the loss of dc input voltages which can be caused by this board or another section of the station. Since there are only two input voltages applied to this board, it is advantageous to verify their presence before beginning extensive troubleshooting.

P903-1, -4	+ 9.6 V dc with respect to chassis
P903-16	Audio A + (approximately + 13.6 V dc with respect to A-)

In a negative ground system audio A- is at chassis potential. In a positive ground system, audio A+ is at chassis potential.

3.3.2 Isolating Defective Components

If tests indicate abnormal performance, a logical troubleshooting procedure should be followed to isolate the defective component efficiently. Results of performance test usually localize the malfunction to one or two stages. The accompanying troubleshooting chart summaryizes these results in a logical sequence. A few waveforms, voltage and resistance checks in the suspected circuit should readily isolate the defective component when compared with those on the schematic diagram.

3.3.3 Troubleshooting Integrated Circuits

Integrated circuits (IC's) are very reliable components and should not be replaced until all checks have proven definitely that the IC is the defective component. Make sure that the external components in the circuit are normal. The IC's on the audio and squelch board may be checked by dc voltage measurements although signal tracing with an oscilloscope is preferred.

3.3.4 Stage Gain Measurements

3.3.4.1 Squelch Circuitry

3.3.4.1.1 This troubleshooting procedure may be used to isolate a squelch malfunction occuring before the detector to a specific state. The test is performed by injecting an ac signal at the input to the squelch circuitry and noting results obtained with an ac voltmeter. Most accurate results are obtained by taking dB gain and loss measurements between points as illustrated in Figure 2. Individual point voltage checks may also be used to quickly verify proper squelch input circuitry operation but this is not an adequate test to prove the circuitry is defective (refer to the following table and Figure 2). Tolerance addition *may* cause increasing variation from the typical readings in the table as readings are taken further from the injected signal point.

3.3.4.1.2 The following procedure may be used for loss and gain or signal level measurements while injecting a 3 kHz or 30 kHz signal. In "Private-Line" radios, PL operation will not affect this test.

Step 1. Turn the VOLUME control fully counterclockwise (off), or to a comfortable listening level, if desired.

Step 2. Turn the SQUELCH control fully clockwise (squelched) and turn the station on.

Step 3. Inject a 1000 microvolt, on-channel signal at the station antenna receptacle. This "quiets" the discriminator output and prevents erroneous test readings.

Step 4. Inject a 3 kHz, 10 millivolt rms signal at the receiver audio & squelch board at P903-9.

Step 5. Take loss and gain measurements or signal level measurements as required.

Step 6. Repeat the preceding test using a 30 kHz signal in place of the 3 kHz signal in Step 4.

3.3.4.2 Audio Circuitry

AC voltage measurements and waveforms are given where applicable on the schematic diagram. Refer to this diagram for pertinent information when taking audio stage gain measurements.

AC Voltmeter Connected to U202-Pin	AC Voltmeter Reading with 3 kHz Signal Input (mV)	AC Voltmeter Reading with 30 kHz Signal Input (mV)
15	3.5	9.5
1	40	110
2	7	85
3	80	950
4	24	750

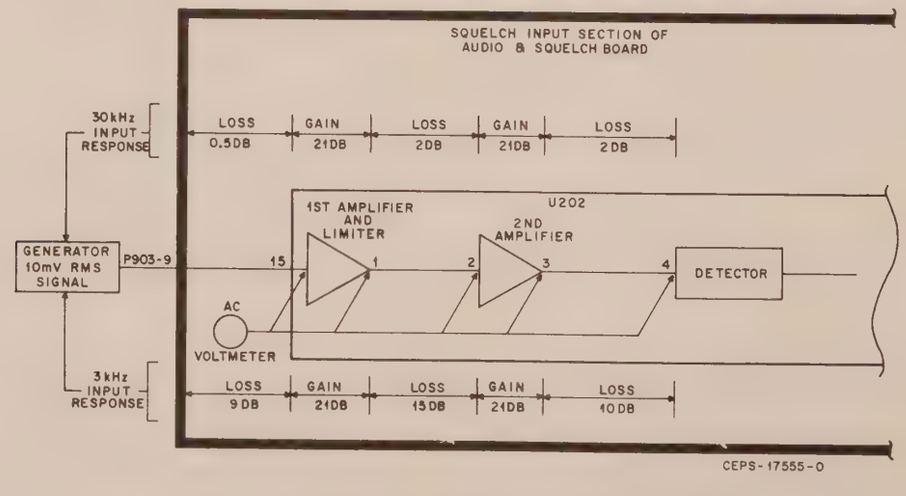
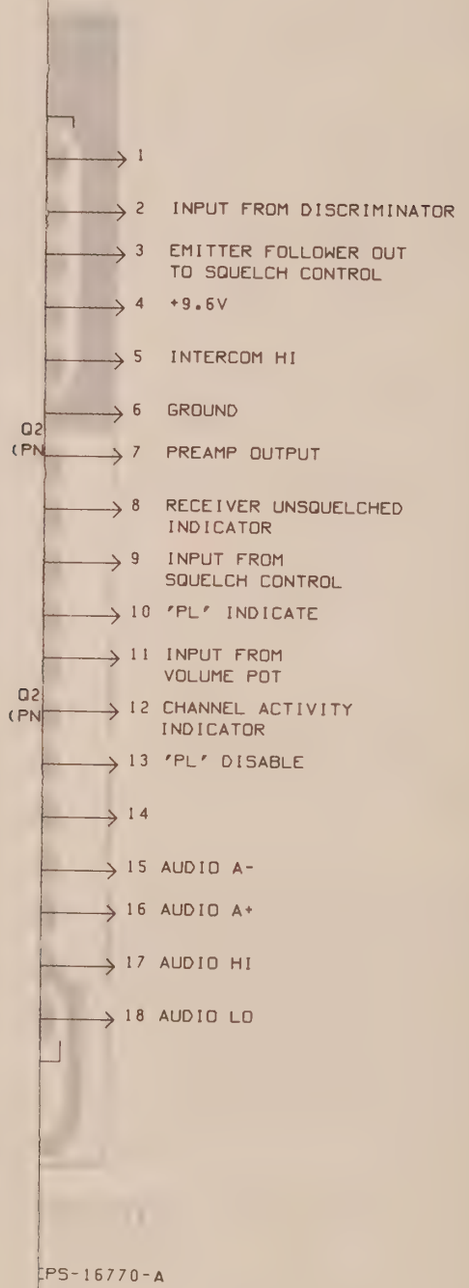


Figure 2. Squelch Circuitry Stage Gain Measurements

"MICOR" "SENSITRON" UHF RECEIVER AUDIO & SQUELCH BOARD

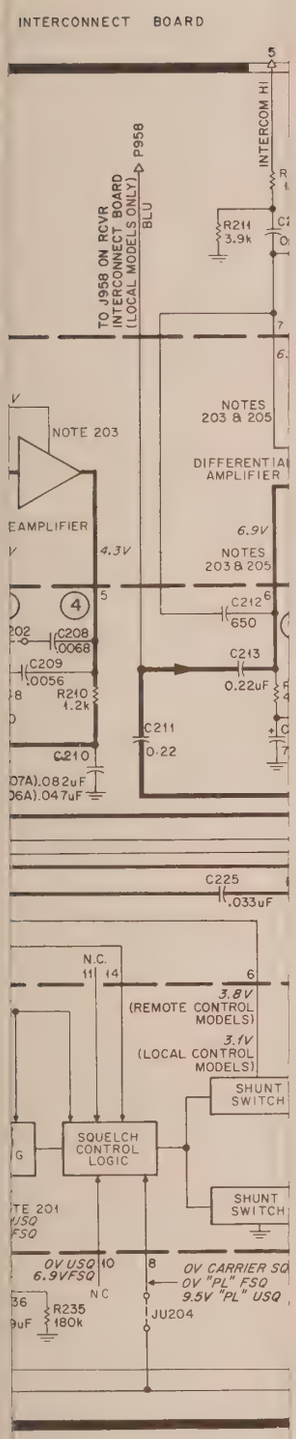
MODEL TRN6006A, AV, 7A



TRN6006A, AV, 7A Audio and Squelch Board Circuit Board Detail, Schematic Diagram, and Parts List
Motorola No. ***PEPS-16952-H***
(Sheet 1 of 2)
7/15/81-PHI

"MICOR" "SENSITRON" UHF RECEIVER AUDIO & SQUELCH BOARD

MODEL TRN6006A, AV, 7A



FUNCTION

— Provides amplification of the low level audio output signal from the receiver rf and i-f.

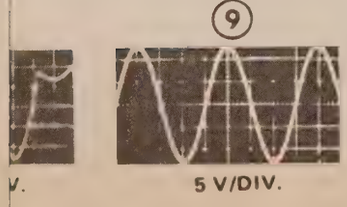
— Provides audio squelch action

Model Usage

Receiver Frequency Range	TRN6006A	TRN6007A
25-50 MHz		X
72-76 MHz		X
132-174 MHz	X	
406-512 MHz	X	

PARTS LIST SHOWN ON BACK

TRN6006A, AV, 7A Audio and Squelch Board Circuit Board Detail, Schematic Diagram, and Parts List
Motorola No. ***PEPS-16952-H***
(Sheet 2 of 2)
7/15/81-PHI



AUDIO & SQUELCH BOARD

AUDIO POWER AMPLIFIER

MODEL TLN4290B

1. DESCRIPTION

The audio power amplifier provides the required power to drive an 8-ohm speaker with 10 watts of audio power, or a 16-ohm speaker with 5 watts of audio power, with less than 5% overall distortion. Two complementary power transistors (NPN and PNP types), operating class AB, with two current limiting resistors, develop this power. The audio drive from the audio and squelch board is routed to this board, amplified, and then returned to the audio and squelch board, where it is applied to the audio output transformer.

The aluminum transistor mounting plate is anodized with a thin, very tough material. This mounting plate provides excellent electrical insulation and thermal conduction properties between the transistors and the heatsink.

2. SERVICING

a. Performance Checks

Performance checks on this board consists of taking resistance readings as is done for any transistor or resistor. It should be noted, however, that many VTVM's and solid-state multimeters do not have sufficient voltage at the test probes to forward bias a transistor junction into conduction and, therefore, should not be used. An inexpensive volt-ohm meter of 1,000 to 20,000 ohms-per-volt sensitivity is sufficient for performing these checks.

NOTE

Do not insert meter test probe tips into female connectors on the board. To do so could cause damage to the connectors and result in poor electrical interconnection with the audio and squelch board.

b. Transistor Replacement

Care must be exercised to prevent damage (such as a scratch) to the mounting plate anodizing at the transistor-mounting plate interface. Should the anodizing in this area become scratched, original performance can only be restored by the use of a new anodized plate. The plate can *not* be "repaired" by the use of any type of insulating washer without a loss in thermal conduction capability.

Factory replacement transistors are supplied with pre-formed leads to properly fit onto the aluminum mounting plate and circuit board. A new nylon shoulder washer is also included.

Step 1. Apply a thin, even coat of silicon grease to the metallic area of the transistor.

Step 2. Mount the transistor using the *new* nylon shoulder washer. Do not solder leads at this time. Tighten the transistor mounting screw.

Step 3. Solder transistor leads to printed circuit board.

TRANSISTOR RESISTANCE MEASUREMENT CHECK
(BOARD REMOVED FROM RADIO — TRANSISTORS MOUNTED ON BOARD)

Ohmmeter Connections		Proper Resistance	
Positive Lead Connected to	**Negative Lead Connected to**	**P-N-P Transistor**	**N-P-N Transistor**
Base	Emmitter, then Collector	Infinite	5-30 Ohms, Both Cases
Emmitter, then Collector	Base	5-30 Ohms, Both Cases	Infinite
Collector	Emitter	Infinite	Infinite
Emitter	Collector	Infinite	Infinite

Failure to obtain these results indicates a defective transistor which must be replaced.

technical writing services
1301 E. Algonquin Road, Schaumburg, Il. 60196
6/20/80-PHI
68P81014E97-H

AUDIO POWER AMPLIFIER

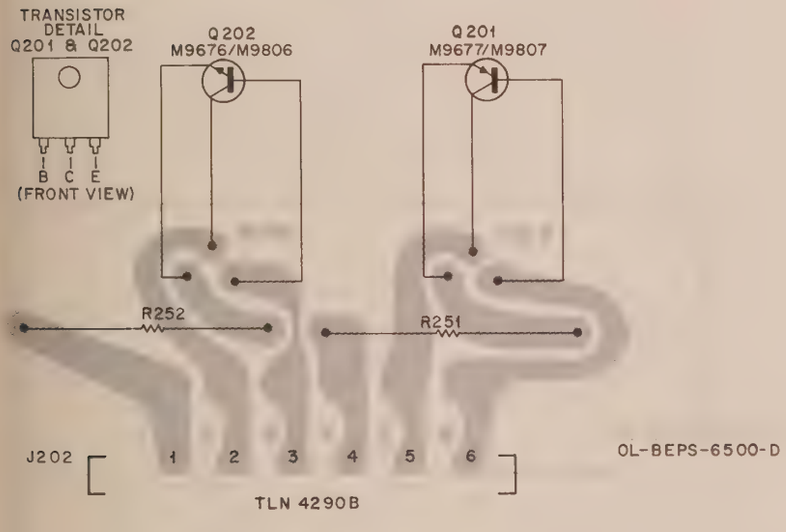
MODEL TLN4290B

FUNCTION

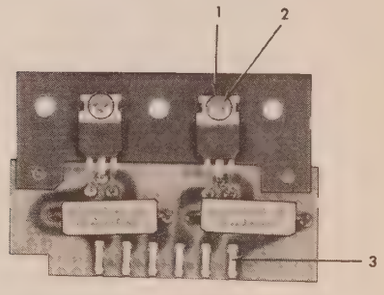
— Provides up to 10 watts audio output.

AUDIO POWER AMPLIFIER

SHOWN FROM SOLDER SIDE



OL-BEPS-6500-D



FAEPS-6502-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

AUDIO POWER AMPLIFIER

TLN4290B Audio Power Amplifier PL-1061-D

J202		CONNECTOR, receptacle: c/o; 9B83011H01 PIN, female; 6 req'd
		TRANSISTOR: (SEE NOTE)
Q201	48R869807	PNP; type M9807
	or48R869677	PNP; type M9677
Q202	48R869806	NPN; type M9806
	or48R869676	NPN type M9676
		RESISTOR, fixed: ±10%; 3 W:
R251	17D82177B49	0.39
R252	17D82177B49	0.39
	MECHANICAL PARTS	
1	4B84180C01	WASHER, shoulder
2	3S129841	SCREW, machine: No. 4-40 x 1/4"; incl. lockwasher
3	9B83011H01	PIN, female

Motorola No. PEPS-28290-O
6/20/80-PHI

STATION DATA

Description 68P81041E74
Installation 68P81042E41
System Audio Level Adjustments 68P81060E24
Station Maintenance 68P81042E51

TRANSMITTER

Transmitter Introduction 68P81042E88
Transmitter Interconnect Board 68P81041E44
Exciter 68P81026E66
Power Amplifier 68P81039E38
Power Control Board 68P81015E07

RECEIVER

Receiver Introduction 68P81042E89
Receiver Interconnect Board 68P81034E07
RF & I-F Board 68P81026E37
Audio & Squelch Board 68P81025E79
Audio & Power Amplifier 68P81014E97

POWER SUPPLIES

Power Supply 68P81020E44
Power Supply 68P81041E49

MISCELLANEOUS

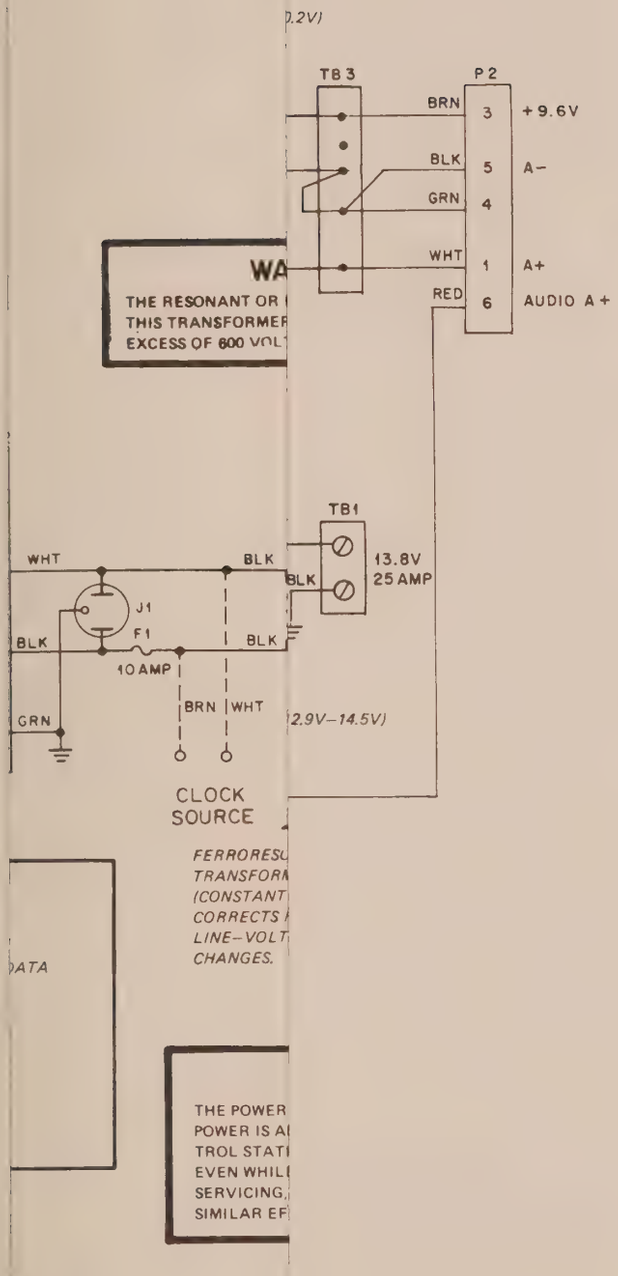
RF Wattmeter 68P81041E76
F0 Kit 68P81042E12
Power Coupler 68P81042E11

REMOTE CHASSIS AND MODULES

Remote Control Chassis 68P81041E51
Line Driver 68P81041E48
Station Control 68P81041E39
Pilot Tone Decoder 68P81041E41
Tone Function Decoder 68P81041E42
Encoder 68P81036E36
DC Function Decoder 68P81041E43
RQS Detector 68P81041E18
RQS Line Current Generator 68P81041E17
Metering Module 68P81041E38
Sub-Audible Paging 68P81044E56

POWER SUPPLY

MODELS TPN1110A
TPN1110B



FUNCTION

Provides regulated 9.6 V dc and 13.6 V dc outputs and a 13.8 V dc unregulated output from a 121 V 60 Hz ac power input. 9.6 V and 13.6 V outputs are automatically adjusted for changes in load or input voltage.

Cable
TKN6658A
TKN6658A

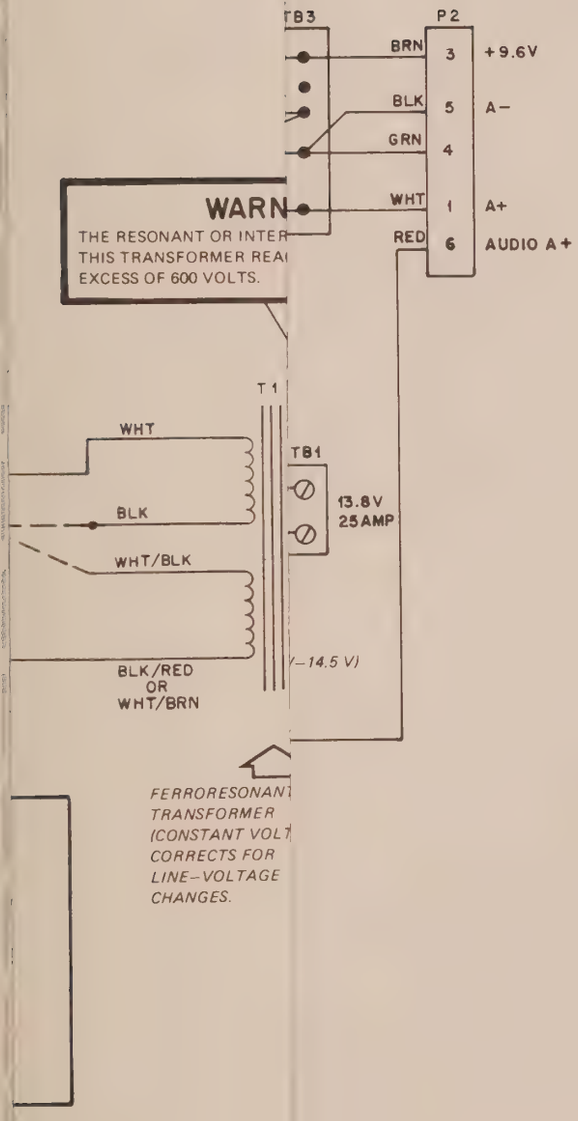
PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

POWER SUPPLY

68P81020E44-M
7/15/81-PHI

POWER SUPPLY

MODEL TPN1165A



FUNCTION

Provides regulated 9.6 V dc and 13.6 V dc outputs and a 13.8 V dc unregulated output from a 120/240 V 50 Hz ac power input. 9.6 V and 13.6 V outputs are automatically adjusted for changes in load or input voltage.

MODEL BREAKDOWN

ITEM	DESCRIPTION
TLN5122A	Regulator Board
TLN5601A	Chassis and Hardware
TKN6658A	Cable Kit

68P81041E49-O
4/15/79- PHI

STATION DATA

Description 68P81041E74
Installation 68P81042E41
System Audio Level Adjustments 68P81060E24
Station Maintenance 68P81042E51

TRANSMITTER

Transmitter Introduction 68P81042E88
Transmitter Interconnect Board 68P81041E44
Exciter 68P81026E66
Power Amplifier 68P81039E38
Power Control Board 68P81015E07

RECEIVER

Receiver Introduction 68P81042E89
Receiver Interconnect Board 68P81034E07
RF & I-F Board 68P81026E37
Audio & Squelch Board 68P81025E79
Audio & Power Amplifier 68P81014E97

POWER SUPPLIES

Power Supply 68P81020E44
Power Supply 68P81041E49

MISCELLANEOUS

RF Wattmeter 68P81041E76
F0 Kit 68P81042E12
Power Coupler 68P81042E11

REMOTE CHASSIS AND MODULES

Remote Control Chassis 68P81041E51
Line Driver 68P81041E48
Station Control 68P81041E39
Pilot Tone Decoder 68P81041E41
Tone Function Decoder 68P81041E42
Encoder 68P81036E36
DC Function Decoder 68P81041E43
RQS Detector 68P81041E18
RQS Line Current Generator 68P81041E17
Metering Module 68P81041E38
Sub-Audible Paging 68P81044E56

This section contains some of the miscellaneous hardware and cable kits used in this station. However, other parts that are referred to may be found elsewhere in this manual or an option publication.

PARTS LIST

TLN5896A Hardware Kit, 1-Receiver
TLN5897A Hardware Kit, 2-Receiver

NOTE

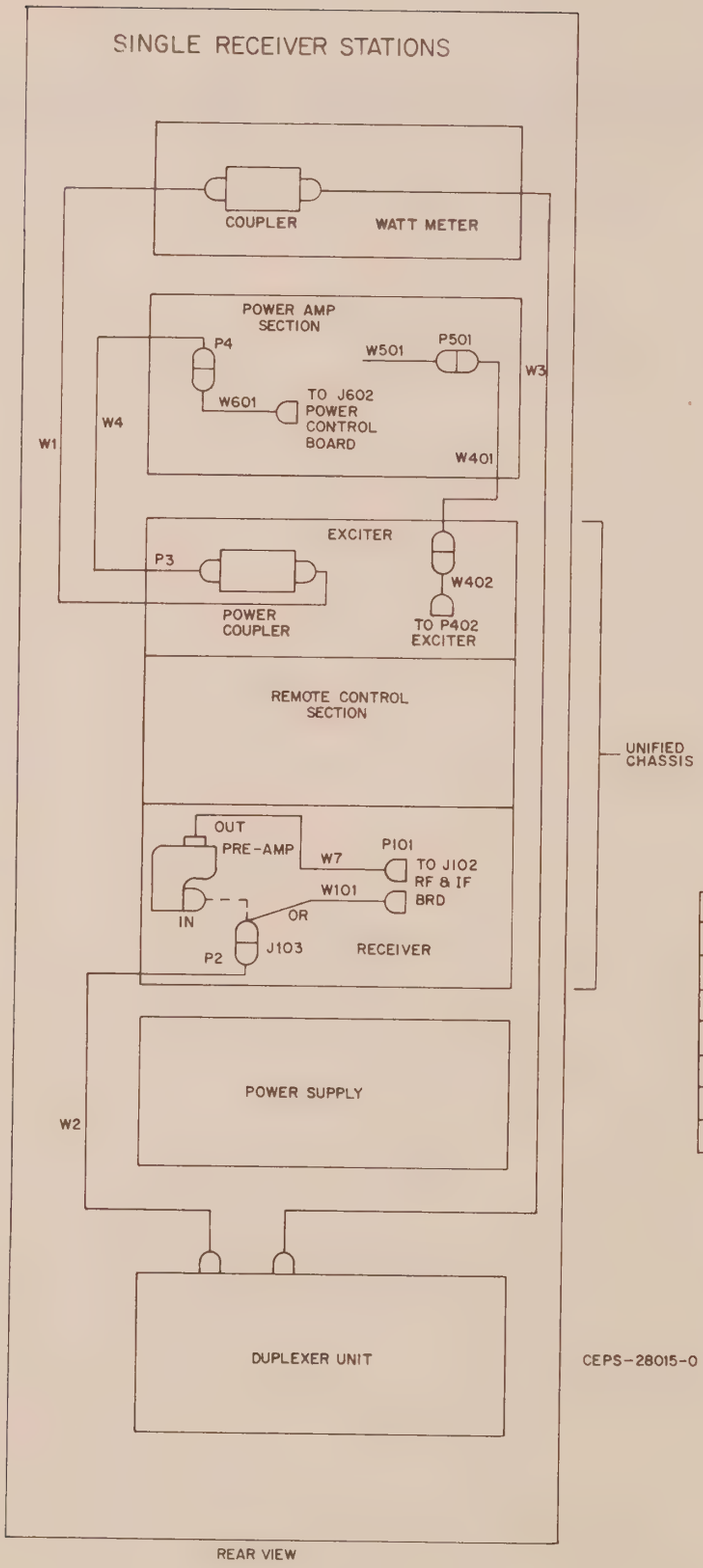
This parts list covers two receiver hardware kits. Where differences appear the model number of the applicable kits is indicated in the description column.

PL-5146-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1-80709B39	SHIELD ASSEMBLY, receiver (TLN5896A 1 used; TLN5897A 2 used) includes:
	2-10101A53	NUT, spring: .280 x .020"; 4 used
	26-84081C04	INSERT, shield
	26-84405B01	SHIELD, receiver
	41-84811B01	SPRING, ground
	46-84090C01	STUD, retainer; 4 used
	1-80728B57	SHIELD ASSEMBLY, Audio & Squelch (TLN5896A 1 used; TLN5897A 2 used) includes:
	2-10101A53	NUT, spring; .280 x .020"; 4 used
	26-84043E01	SHIELD (4-hole)
	26-84981F01	SHIELD (2-hole)
	46-84090C01	STUD, retainer
	1-80731B73	SHIELD ASSEMBLY, Exciter includes:
	2-10101A53	NUT, spring: .280 x .020"; 4 used
	26-84053E01	SHIELD, exciter
	26-84053E04	INSERT
	46-84090C01	STUD, retainer; 4 used
	1-80775B77	BRACKET ASSEMBLY includes:
	7-82898K01	BRACKET, connector mtg.
	1-80792B92	COVER ASSEMBLY, channel element (TLN5896A 1 used; TLN5897A 2 used) includes:
	1-80792B93	COVER SUBASSEMBLY includes:
	64-82673L02	COVER
	3-138162	SCREW, tapping: 4-40 x 3/8" 4 used
	42-84284B01	RETAINER, screw; 4 used
	75-82902K01	PAD, rubber
	2-119913	NUT, hex; 8-32 x 11/32 x 1/8"; 3 used
	2-82360B07	NUT, speed: 1/4 - 14 (TLN5896A 18 used: TLN5897A 22 used)
	3-122777	SCREW, machine: 8-32 x 1/2"; 3 used
	3-134268	SCREW, tapping: 4-40 x 7/16"; 2 used
	3-135038	SCREW, tapping: 1/4-14 x 3/4" (TLN5896A 18 used; TLN5897A 22 used)
	3-138162	SCREW, tapping; 4-40 x 3/8"
	3-139495	SCREW, tapping; 6-20 x 5/16" 2 used
	7-82683K01	BRACKET, filter
	13-813618	DECAL, patent number
	14-82903K01	INSULATOR; 2.68 x 1.25"
	26-82911K01	HEAT SINK
	33-83051K01	NAMEPLATE
	42-10217A02	STRAP, cable harness; 3.67" lg.; 10 used
	42-10217A10	STRAP, cable harness; 7.78" lg.; 3 used
	42-84284B01	RETAINER, screw
	54-842366	LABEL, replacement parts
	54-850440	LABEL, FCC
	54-83040C01	LABEL, audio
	54-84857B01	LABEL, wattmeter
	55-84300B01	HANDLE; (TLN5896A 4 used; TLN5897A 6 used)
	66-84387C01	TOOL, universal tuning
	66-84690C01	TOOL, contact removal

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196



REFERENCE	PART OF
W1	TLD5571A
* W2, W3	TKN6473A OR TKN6892
W4	TKN6581A
* W7	TLE8191A OR TLE8192A
W101	TKN6570A
W401	TKN6883A
W402	TKN6581A

* DEPENDENT UPON OPTION SELECTED

Figure 1. Station Intercabling Diagram

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

PARTS LIST

TKN6581A Exciter RF Cable Kit PL-1782-A

W401	TKN6581A	CABLE ASSEMBLY: includes: 30B83794C01 CABLE, coaxial; 8" lg. 9A84968D01 CONNECTOR, plug; BNC bulkhead type 28B82331G01 CONNECTOR, plug; single contact

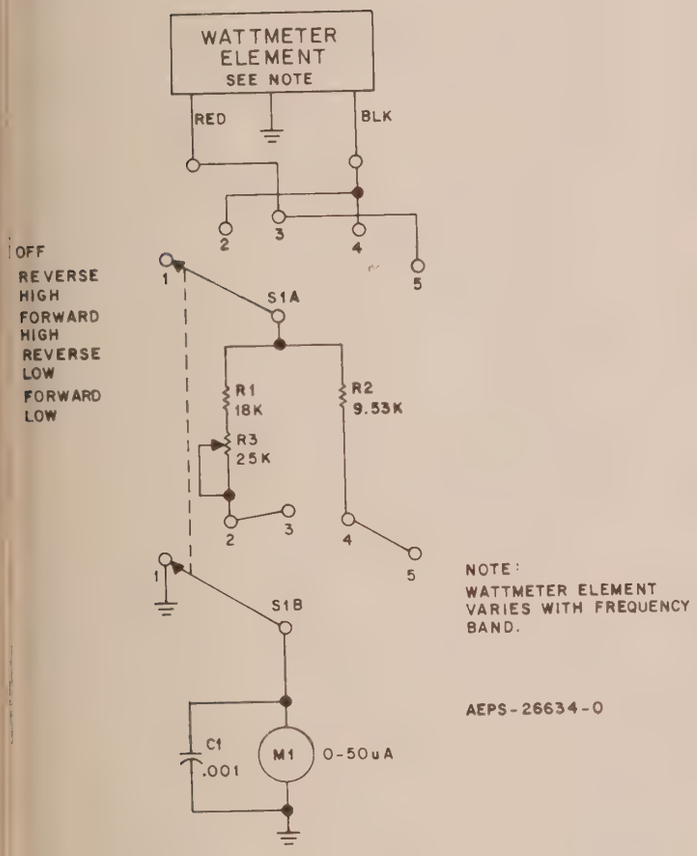
TKN6883A RF Cable Kit, RPTR PL-5148-(

W401	1-80792B95 28-84967D01 30-84173E01	CABLE ASSEMBLY: includes: CONNECTOR, plug: BNC type; 2 used CABLE, coaxial: 16" lg.
NON-REFERENCED ITEMS		
	1-80793B02 9-84234E10 29-824151 29-824154 30-813233 30-831572 37-82603D60	CABLE ASSEMBLY includes: JACK, test: (White) LUG, slotted tongue: 2 used LUG, ring tongue: 2 used CABLE, battery: #10 (red); 44" lg. CABLE, battery: #10 (black) 44" lg. SLEEVE, number: (blank)

RF WATTMETER

MODELS TLE8911A (UHF)
TLD5571A (VHF)

Provides a convenient method of monitoring the transmitter rf output power. The function switch allows the selection of forward and reverse power in either a high or low meter range.



parts list

TLD5571A Wattmeter
TLE8911A Wattmeter

PL-6400-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
C1	21-859601	.001 uF ± 20%; 600 V
		meter:
M1	72-84864B16	50 uH
		resistor, fixed:
R1	6-124A79	18k ± 5%; 1/4 W
R2	6-83175C92	9.53k ± 1%; 1/4
R3	18-82515B28	variable; 25k
		switch; rotary:
S1	40-82560H02	2 pole; 5 position
		mechanical parts
	2-7018	NUT, 3/8-32 x 1/2 x 3/32"
	2-132616	NUT, 6-32 x 1/4 x 3/32 x 1/8"; 2 used
	2-136272	NUT, 3/8-32 x 1/2 x 1/16
	2-82360B07	NUT, speed
	3-135038	SCREW, tapping: 14-14 x 3/4"; 4 used
	3-136138	SCREW, tapping; 6-32 x 3/8"; 6 used
	3-135926	SCREW, tapping; 4-40 x 5/16; 2 used
	4-7691	LOCKWASHER, 3/8 internal
	4-7698	LOCKWASHER, 3/8 internal
	29-82578C01	LUG, ring tongue; 2 used
	36-82630H01	KNOB, control
	42-76724	CLIP, cable
	42-861179	CLIP, cable
	42-10217A02	STRIP, tie
	58-84918L02	ELEMENT, wattmeter (450-512 MHz)
	58-84818L01	ELEMENT, watmeter (150.8-174 MHz)
	64-83168L01	PANEL
	64-83525L01	PLATE
	28-84476G01	CONNECTOR, plug; male; 2 used
	7-83169L01	BRACKET

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

/15/76- PHI

68P81041E76-O

F-ZERO (FØ) KIT

MODELS TLN1956A (VHF)
TLN1957A (UHF)

FUNCTION

The FØ kit reduces the possible creation of a false MARK IDLE channel due to intermodulation. In IMTS systems, the mobile searches for a channel with an idle tone and locks onto it. If the mobile locks on to a false MARK IDLE channel, it will not be capable of placing or receiving calls.

In stations equipped with the FØ kit, the transmitter can be keyed either at the standard specified power output or at approximately 1/2 watt (FØ mode). Either of these modes can be selected remotely via the control lines or the FØ mode can be selected locally by the FØ switch.

68P81042E12-A
7/15/81-PHI

POWER COUPLER

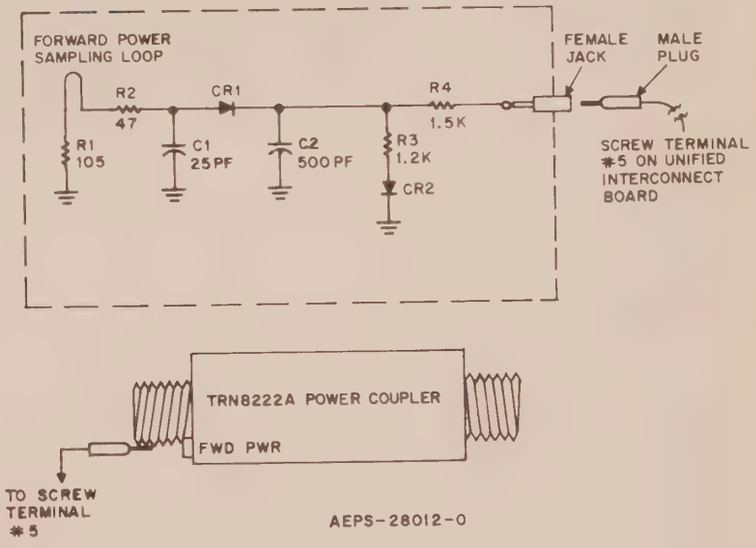
MODEL TRN8222A

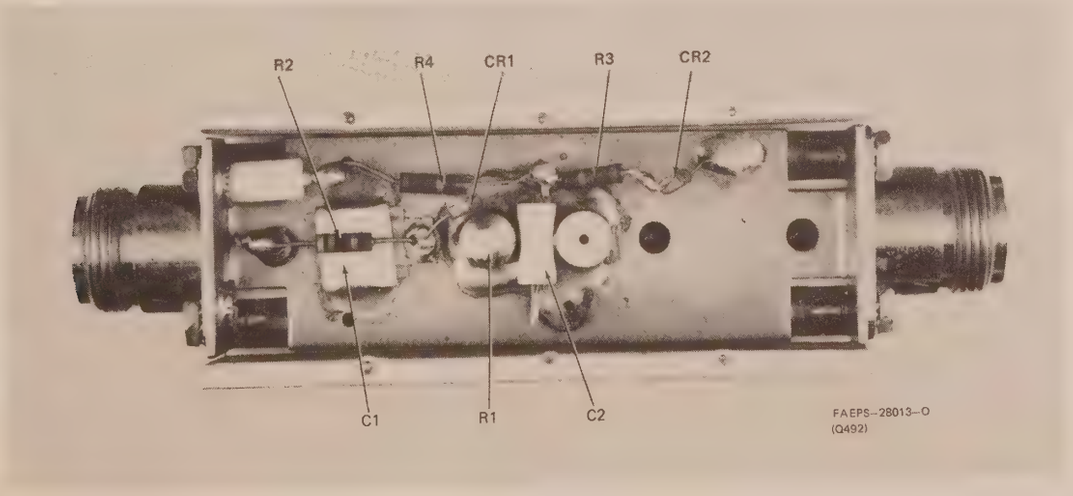
parts list

T48222A Power Coupler PL-6445-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
1	21-82880E16	25 pF ± 10%; 850 V
2	21-82880E27	2 x 250 pF ± 10%; 500 V
		diode: (see note)
R1,2	48-84616A01	hot-carrier
		coil, rf:
1	24-83648C05	pick-up loop
		resistor, fixed: ± 5%; 1/4 W: unless otherwise stated
1	6-83175C95	105 ± 1%
2	6-124A17	47
3	6-124A51	1.2k
4	6-124A53	1.5k
		mechanical parts
	15-83651C01	COVER, directional coupler
	3-134212	SCREW, tapping: 4-40 x 5/16"; 4 used
	3-7164	SCREW, machine: 6-32 x 1/4"; 4 used
	58-844807	ADAPTER, straight: type UG57 B/U
	1-80705D31	CABLE, assembly (Sense Output) includes:
	28-15167A22	PLUG, male: red tip
	29-847854	LUG, slotted tongue
	1-80705D32	EXTRUSION COUPLER includes:
	7-83650C01	EXTRUSION, coupler
	9-816159	RECEPTACLE, chassis; 2 used
	47-83654C03	TUBING, rf line
	3-134212	SCREW, tapping: 4-40 x 5/16"; 4 used
	1-80705D34	CHASSIS, assembly includes: ref. items R1 thru 4, C2, CR1, 2
	1-80705D33	CHASSIS, eyeleted includes ref. item C1
	27-83630C05	CHASSIS
	29-120491	LUG, solder
	43-83655C01	BUSHING, resistor
	43-83656C01	BUSHING
	9-83649C01	JACK, test: wht

Senses the presence of rf power in a working station, developing the control voltage used in the power detect circuitry of the station control module.





POWER COUPLER

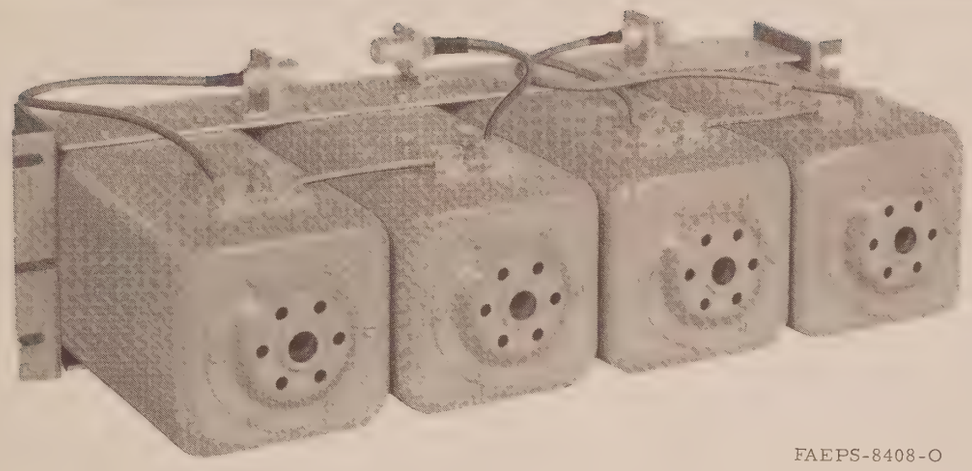
MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

68P81042E11-O
4/15/79- PHI

FILTERS AND DUPLEXERS

T1480A SERIES
148-174 MHz



FAEPS-8408-O

1. INTRODUCTION

These filters and duplexers are for use with "Motorola" FM two-way radio communications equipment operating in the 148-174 MHz frequency range. They utilize cavity resonators with a special internal loading construction to achieve a size much less than one-quarter wavelength and are tuned with an adjustable center conductor. The resonators use a unique temperature compensating mechanism and uniquely adjustable coupling loops. Specially designed low-profile cable connectors are used to obtain an extremely compact package.

These units may be used in the antenna circuit of a base station or repeater to eliminate or minimize receiver desensitization or intermodulation from strong signals. Similarly, they may be used to reduce transmitter noise or intermodulation products.

2. INSTALLATION

a. Bracket-Mounted Filters

(1) Carefully unpack the unit and check for concealed damage.

(2) Select a mounting location near the associated equipment or inside the equipment cabinet that will permit using the shortest cabling between the filter and the equipment.

(3) Using the mounting bracket as a template, mark the locations of the desired mounting holes.

(4) Drill the mounting holes required by the type of mounting hardware to be used.

(5) Mount the filter using the hardware supplied.

(6) Connect the filter to the transmitter or receiver. Cables external to the filter are not of a critical length.

MOTOROLA INC.
Communications Division

service publications
1301 E. Algonquin Road, Schaumburg, IL 60196

©Motorola, Inc. 1979
Printed in U.S.A.

68P81102E85-E
6/16/79-PHI

PERFORMANCE SPECIFICATIONS

FILTERS

MODEL NUMBER	T1481A	T1482A
INSERTION LOSS	0.6 dB	1.3 dB
MAXIMUM POWER INPUT	125 W	125 W
MINIMUM PASS-REJECT SEPARATION	1.5 MHz	±1.5 MHz
MINIMUM REJECT ATTENUATION	35 dB @ 1.5 MHz	42 dB @ 1.5 MHz
TEMPERATURE RANGE	-30°C to +60°C	-30°C to +60°C
SIZE	6" x 5" x 8-1/2"	19" x 5-1/2" x 8-1/2"
TERMINATION	N Female	N Female

DUPLEXERS

MODEL NUMBER	T1485A	T1485AF	T1487A	T1487AF
INSERTION LOSS	0.7 dB	0.9 dB	1.5 dB	1.7 dB
ISOLATION AT TRANSMIT FREQUENCY	52 dB		82 dB	
ISOLATION AT RECEIVER FREQUENCY	52 dB		82 dB	
MINIMUM TRANSMITTER RECEIVER ISOLATION	35 dB		52 dB	
MINIMUM FREQUENCY SEPARATION	3 MHz		1.5 MHz	
VSWR MAXIMUM	1.5:1		1.5:1	
MAXIMUM POWER INPUT	125 W		125 W	
TEMPERATURE RANGE	-30°C to +60°C		-30°C to +60°C	
SIZE	19" x 5-1/2" x 8-1/2"		19" x 5-1/2" x 8-1/2"	
TERMINATION	N Female		N Female	

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

EPS-8409-O

MOTOROLA

MODEL CHART

FOR

FILTERS AND DUPLEXERS

148-174 MHz

CODE:

[X] = ONE ITEM SUPPLIED.

[2] = NUMBER INDICATES QUANTITY OF ITEMS SUPPLIED.

MODEL	DESCRIPTION	TLD8392A CAVITY FILTER KIT	TKN6471A CABLE KIT	TKN6472A CABLE KIT	TKN6473A CABLE KIT	TKN6474A CABLE KIT	TLN4565A MOUNTING HARDWARE KIT	TLN4566A MOUNTING HARDWARE KIT
T1481A	PASS-REJECT FILTER	X		X			X	
T1482A	DUAL-REJECT FILTER	2	X	X				X
T1485A	TWO-CAVITY PASS-REJECT DUPLEXER	2		X	X			X
T1485AF	TWO-CAVITY PASS-REJECT DUPLEXER (FACTORY-INSTALLED)	2			X	X		X
T1487A	FOUR-CAVITY PASS-REJECT DUPLEXER	4	2	X	X			X
T1487AF	FOUR-CAVITY PASS-REJECT DUPLEXER (FACTORY-INSTALLED)	4	2		X	X		X

EPS-8410-O

b. Rack Panel-Mounted Units

(1) Carefully unpack the unit and check for concealed damage.

(2) The units are designed to mount on any standard 19-inch relay rack. Select position in rack for best location of unit, i.e., closest proximity to associated equipment inputs and outputs.

(3) Mount unit in place in rack with appropriate mounting hardware. The hardware supplied is intended for use with "Motorola" base stations.

(4) Connect the filter or duplexer to the transmitter and receiver.

(5) Duplexers and filters must be installed with appropriate lengths of 50-ohm coaxial cable (not supplied) to fit the individual installation.

3. THEORY OF OPERATION

Each resonant cavity, technically a re-entrant quarter-wave resonator, is a very high Q (low loss) tunable tank circuit. A special internal construction uses two different characteristic impedances for the center conductor to achieve an overall length considerably less than a quarter-wavelength. The dimensions are designed for minimum loss. The cavities are tuned to the required pass frequency by an adjustment which changes the length of the center conductor. Lower frequencies have more of the center conductor inside the cavity, higher frequencies have correspondingly less. Special bimetal washers are used for temperature compensation to minimize detuning due to ambient temperature changes.

Each resonant cavity is fitted with a specially designed pair of coupling elements (loops). These loops efficiently convert energy from the 50-ohm coaxial cable to the correct mode inside the resonant structure. When the cavity is not tuned to resonance, most of the energy is reflected. Only a small portion is able to excite the correct mode and reach the output element.

The input and output coupling loops are placed very close to each other, to take advantage of mutual coupling. A small amount of energy is always being transferred between coupling loops because of their proximity. At one frequency, the energy transferred by mutual coupling cancels the energy transferred across by the resonant mode within the cavity. Thus, at one frequency, there is a reject notch in addition to the normal selectivity of the cavity. The proximity of the loops provides inductive coupling. In addition, a precision high Q trimmer capacitor is connected across the loops. This capacitor can adjust the net coupling to be inductive or capacitive. When the net coupling is inductive, the notch occurs above the pass frequency. When the net coupling is capacitive, the notch occurs below the pass frequency.

Cavities are used on each side of a duplexer. The cavities tuned to pass the lower frequency have the coupling loops tuned to notch out the higher frequency, while the cavities tuned to pass the higher frequency have the coupling loops tuned to notch out the lower frequency. Quarter-wave coupling is used between cavities to obtain minimum pass band bandwidth and minimum insertion loss.

4. REMOVAL/REPLACEMENT OF COUPLING LOOPS

Coupling loops are factory-installed in all T1480A Series Cavity Filters and Duplexers. If it becomes necessary to change coupling loops, refer to Figures 1, 2 and 3 and use the following procedure.

a. Removal Procedure

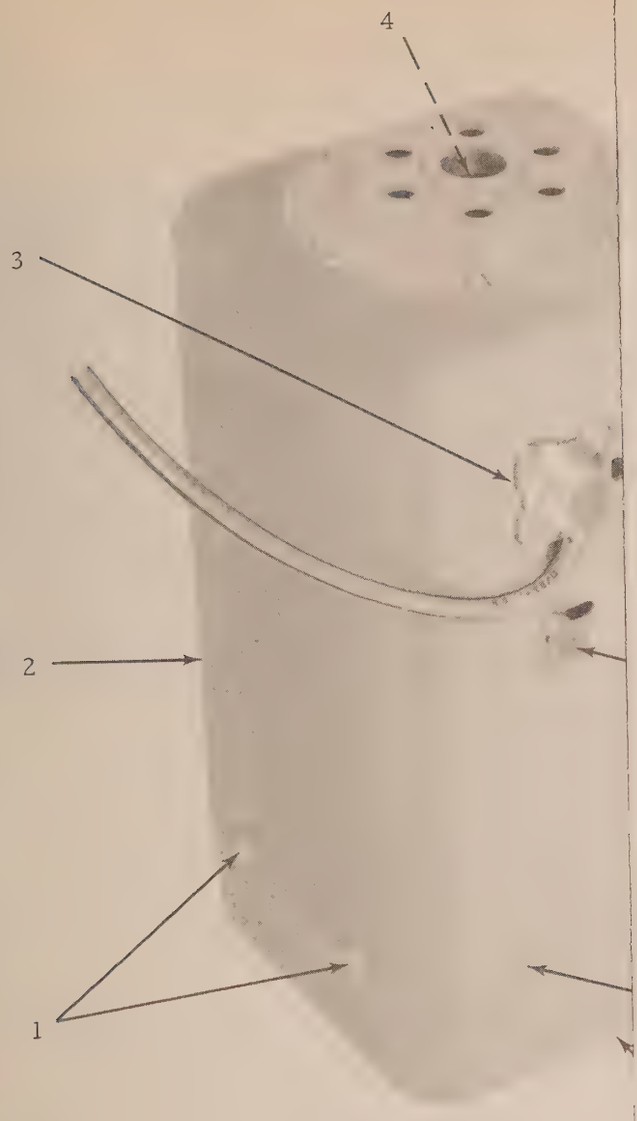
The cable shields are soldered to the connector portion of the loops. These shields must first be unsoldered before the loops can be removed. The shields cannot be unsoldered while the connectors are attached to the cavity body because the cavity body acts as a heat sink.

(1) Remove the eight screws securing the connectors to the cavity body.

(2) The two coupling loops are internally connected and must be removed together. Using a 150-watt soldering iron, first unsolder and remove the connector covers from the two connectors.

(3) Grasp the center conductor of the cable (at the point where it enters the center pin of the connector) with long nose pliers. Melt the solder around the cable shield and pull the cable off the connector. Do the same for the other connector.

(4) Remove the two knurled adjusting knobs taking care not to lose the washers. Now the loops are completely free and can be removed from the can.



FAEPS-8411-O

Figure 1
Cavity Filter
Location De

NOTE:

THE OVERALL DIMENSIONS AND TH
CABLES ARE CRITICAL, AND IT IS T
COMMENDED THAT AN ENTIRE CAB
USING THE CORRECT TKN NUMBER
TKN6473A OR TKN6474A). THE CON
(CODE NO. 6) ARE INCLUDED IN THE

PARTS LIST

TLD8392A Cavity Filter PL-1677-O

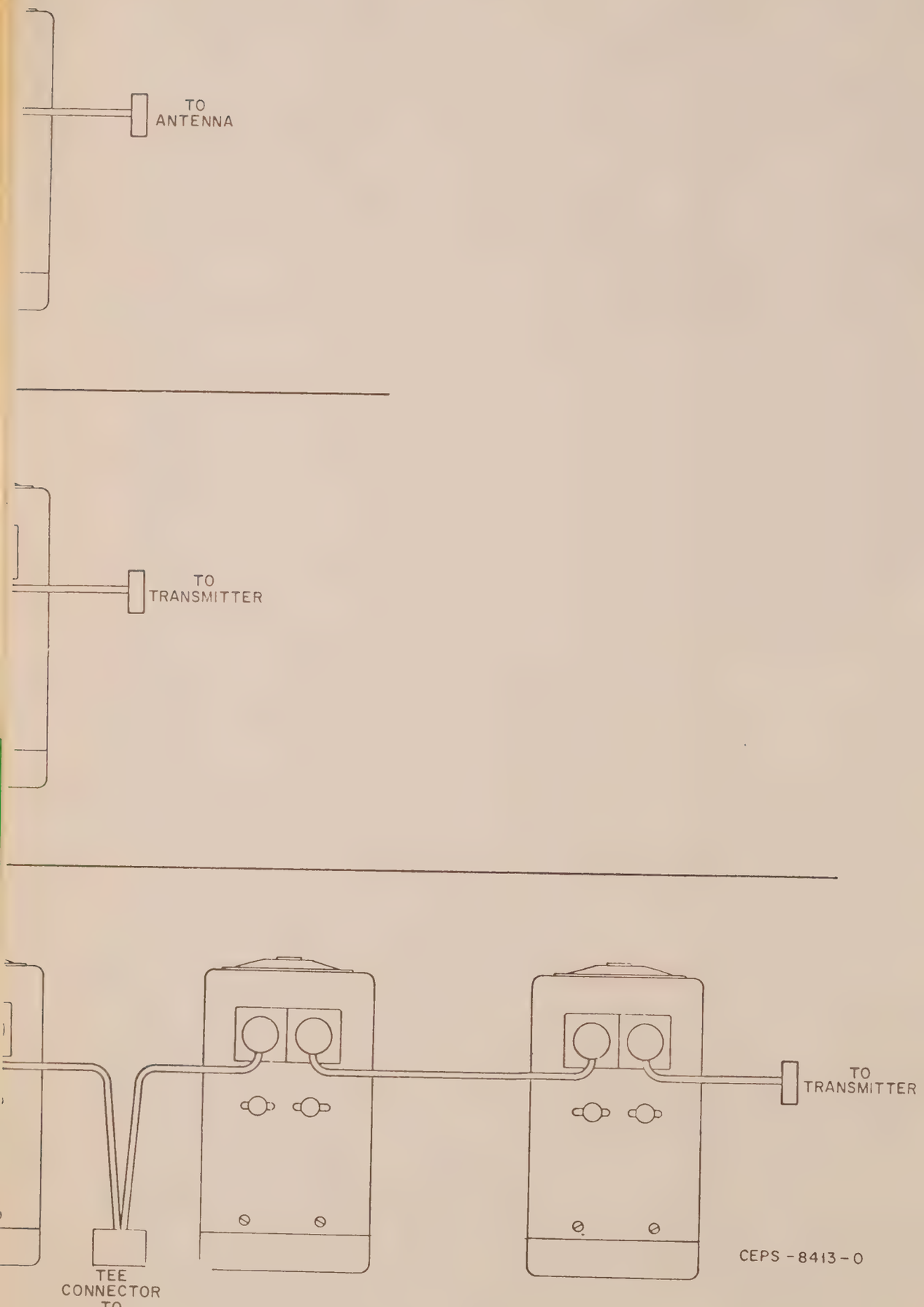
CODE	MOTOROLA PART NO.	DESCRIPTION
1	3-3375	SCREW, tapping: 6-20 x 5/16" plain hex head (4 req'd)
2	1-84312D01	CAVITY ASSEMBLY
3	1-80723B90	LOOP ASSEMBLY, coupling
4	47-84313D01	TUNING SHAFT
5	3-134168	SCREW, tapping: 4-32 x 1/4" Phillips hex head; internal lockwasher (8 req'd)
7	3-82245E04	SCREW, knurled head (2 req'd)
7	4-9746	LOCKWASHER: No. 8 med. split (2 req'd)
7	4-82418B01	WASHER, nylon (2 req'd)
9	15-84993C02	COVER, housing
10	4-84994C01	WASHER, temperature compensating ("LE" stamped on concave side)
11	4-84994C02	WASHER, temperature compensating ("LE" stamped on convex side)
12	1-84985C01	LOCKING NUT ASSEMBLY
13	3-7110	SCREW, set: 8-32 x 3/16" allen head
14	1-84314D01	TUNING CAN ASSEMBLY
15	42-824977	RING, truarc

TLN4565A Mounting Hardware Kit (1-Cavity) PL-1678-O

CODE	MOTOROLA PART NO.	DESCRIPTION
	7-84395D01	BRACKET, cavity mtg
8	3-3398	SCREW, tapping: 6-20 x 3/8" plain hex head (4 req'd)
	3-1209	SCREW, machine: 10-32 x 1/2" slotted binder head (4 req'd)
	3-7658	LOCKWASHER: No. 10 internal (4 req'd)
	2-7048	NUT, machine: 10-32 x 5/16" hex (4 req'd)
	3-136716	SCREW, wood: No. 10 x 1-1/2" slotted round head (4 req'd)
	33-84002B01	NAMEPLATE, cavity
	66-82846D01	TOOL, tuning

TLN4566A Mounting Hardware Kit (2 or 4-Cavities) PL-1679-O

CODE	MOTOROLA PART NO.	DESCRIPTION
	64-84003D01	PANEL, cavity mtg (top)
	64-84004D01	PANEL, cavity mtg (bottom)
8	3-3398	SCREW, tapping: 6-20 x 3/8" plain hex head (16 req'd)
	3-128109	SCREW: 6-32 x 1/4" slotted round head; external lockwasher (6 req'd)
	3-135038	SCREW, tapping: No. 14 x 3/4" Phillips pan head (4 req'd)
	2-82360B07	NUT, sheet spring: ("clip-on"); type "U" (4 req'd)
	4-812732	WASHER, cushion (4 req'd)
	33-84333B01	NAMEPLATE
	66-82846D01	TOOL, tuning


TO
ANTENNA
TO
TRANSMITTER
TO
TRANSMITTER
TEE
CONNECTOR
TO
ANTENNA
CEPS-8413-0

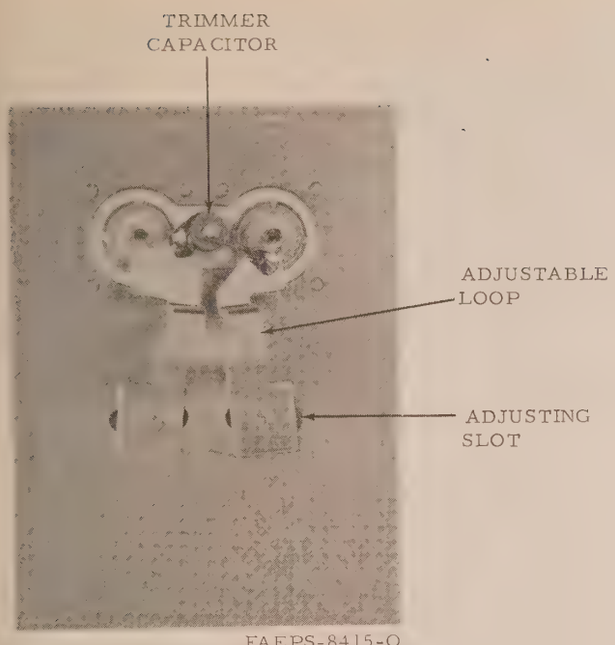


Figure 3.
Coupling Loop (Interior View)

(5) Maneuver both loops to the left so that the trimmer capacitor can fit through the left side of the hole and then remove the two loops together.

b. Replacement Procedure

(1) Insert the loop assembly into the mounting holes and maneuver both loops to the left so that the trimmer capacitor will fit through the left side of the hole.

(2) Position the loops so that the tapped holes in the end of the loops are visible through the adjusting slots.

(3) Insert the knurled adjusting screw, along with the nylon and lock washers, into the tapped hole.

(4) Attach the connectors to the can using the eight self-tapping screws making certain that the connector cable slot is facing in the proper direction to insert the cable.

(5) Insert the cable into the connector cable slot while pressing the center conductor into the center pin of the connector.

(6) Place the connector cover over the connector and solder the cable shield and connector cover to the connector.

5. RECOMMENDED TUNING PROCEDURE

All filters and duplexers are tuned to the customer-specified frequencies prior to shipment from the factor. If system performance indicates that the duplexer is detuned, one of the following procedures may be used. Do not attempt to retune unless the following procedures have been read and it is certain that performance does not meet specifications.

The following tuning procedures assume that the entire duplexer is to be retuned. If it is desired to perform a minor "touch-up", refer to paragraph e. of this tuning procedure. When left and right are used in the following procedures, this shall mean facing the tuning shaft end and with the connectors facing up.

a. Method 1 (Models T1485A, AF and T1487A, AF)

(1) Recommended Test Equipment

(a) "Motorola Model R1201 Series Signal Generator.

(b) Tunable receiver or two "Motorola" receivers, one tuned to each of the frequencies to be duplexed.

(2) Tuning Procedure

(a) Move sliding screws as far apart as possible on each cavity and then tighten the screws.

(b) Turn trimmer capacitors fully counterclockwise.

(c) Tune the signal generator and the receiver to the duplex receive frequency.

(d) Connect the signal generator to the antenna port and the receiver to the right-hand port.

(e) Tune the right-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.

(f) Tune the signal generator and the receiver to the duplex transmit frequency.

(g) Connect the receiver to the left-hand port.

(h) Tune the left-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.

(i) Connect the receiver to the right-hand port.

(j) Tune the right-hand cavity(s) for maximum attenuation by using procedure 5.f., "Tuning the Notch".

(k) Tune the signal generator and the receiver to the duplex receive frequency.

(l) Connect the receiver to the left-hand port.

(m) Tune the left-hand cavity(s) for maximum attenuation by using procedure 5.f.

(n) Repeat steps (c) through (m), but only tune the trimmer capacitors when tuning the notches.

b. Method 2 (Models T1485A, AF and T1487A, AF)

(1) Recommended Test Equipment

(a) Mixer circuit constructed as shown in Figure 4.

(b) "Motorola" R1201 Series Signal Generator.

(c) IF output from R1201 Series Signal Generator equal to the duplex frequency separation or a "Motorola" S1056B Portable Test Set with a crystal frequency equal to the duplex frequency separation.

(d) "Motorola" S1350A Wattmeter.

(e) "Motorola" T1013A RF Load Resistor.

(f) Isolated Tee connector (construct this by removing the Tee port center pin of a UHF Tee connector). This provides 30 to 40 dB of isolation between the shunt path and the direct path through the Tee to protect the receiver when the transmitter is keyed.

(g) Transmitter and receiver from the station to be duplexed.

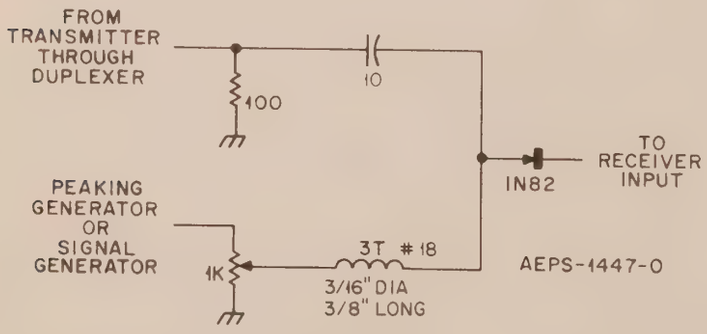


Figure 4.
Mixer Circuit

(2) Operation of the Mixer Circuit

Alignment of the duplexers can be simplified by using the mixer circuit shown in Figure 4. The mixer receives inputs from the transmitter and a low frequency source. The outputs from the mixer are frequencies above and below the transmitter frequency at separations equal to the output of the low frequency generator.

The receiver will respond to one of the mixer products and thus can be used indirectly to detect the transmitter frequency.

(3) Tuning Procedure

(a) Move sliding screws as far apart as possible on each cavity and then tighten the screws.

(b) Turn trimmer capacitors fully counterclockwise.

(c) Connect the equipment as shown in Figure 5.

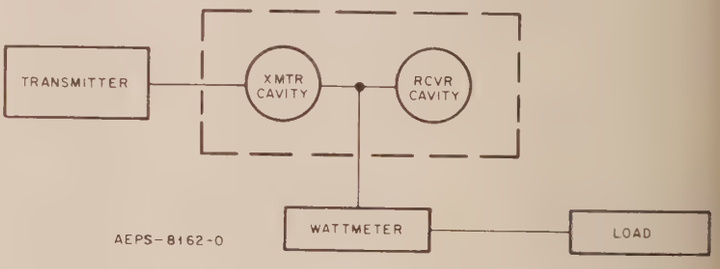


Figure 5.
Method 2 Transmitter Branch
Pass Test Set-Up

(d) Tune the left-hand cavity(s) for a maximum power reading on the wattmeter by adjusting the tuning rod screw.

(e) Connect the equipment as shown in Figure 6.

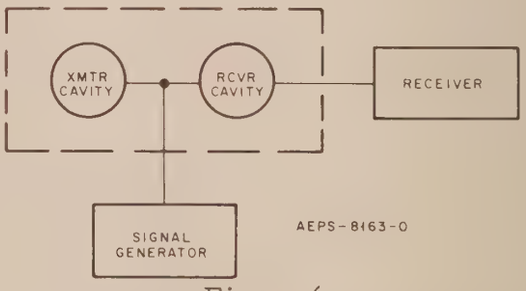


Figure 6.
Method 2 Receiver Branch
Pass Test Set-Up

(f) Tune the signal generator to the receive frequency.

(g) Tune the right-hand cavity(s) for a minimum insertion loss (maximum signal at the receiver) by adjusting the tuning rod screw.

(h) Connect the equipment as shown in Figure 7.

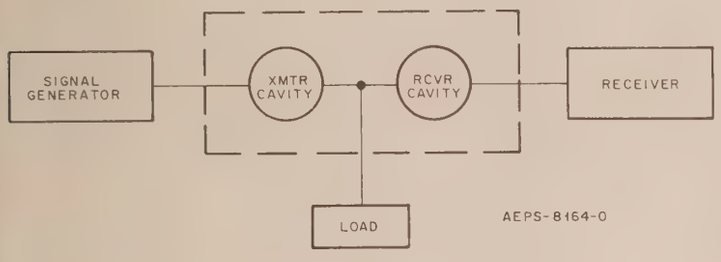


Figure 7.
Method 2 Transmitter Branch
Reject Test Set-Up

(i) Tune the left-hand cavity(s) for maximum attenuation by using procedure 5.f., "Tuning the Notch".

(j) Connect the equipment as shown in Figure 8.

(k) Set the local oscillator source to the exact duplex frequency separation.

(l) Tune the right-hand cavity(s) for maximum attenuation by using procedure 5.f.

(m) Repeat steps (c) through (l) but only tune the trimmer capacitors when tuning the notches.

(4) Connect the duplexer to the transmitter, receiver and antenna with 50-ohm coaxial cable. Adjust the transmitter final amplifier for rated power into the duplexer.

c. Model T1481A

This model may be tuned by using only steps (1) and steps (2)(a) through (e) and (j) and (k) of Method 1.

d. Model T1482A

(1) Recommended Test Equipment

(a) "Motorola" R1201 Series Signal Generator.

(b) Tunable receiver.

(2) Tuning Procedure

(a) Move sliding screws as far apart as possible on each cavity and then tighten the screws.

(b) Turn the trimmer capacitors fully counterclockwise.

(c) Tune the signal generator and the receiver to the pass frequency.

(d) Connect the equipment as shown in Figure 9.

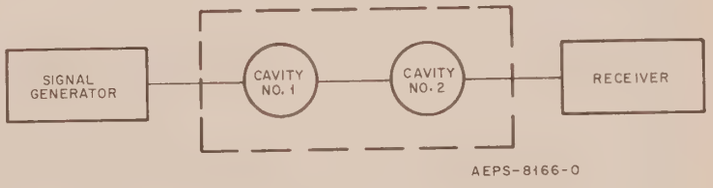


Figure 9.
Model T1482A Test Set-Up

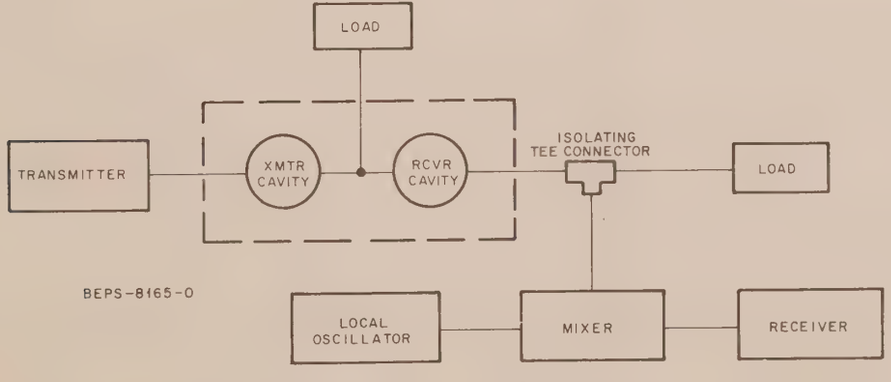


Figure 8.
Method 2 Receiver Branch Reject Test Set-Up

(e) Tune both cavities for minimum insertion loss by adjusting the tuning rod screw.

(f) Tune the signal generator and the receiver to the lower notch frequency.

(g) Tune the left-hand cavity for maximum attenuation by using procedure 5.f.

(h) Tune the signal generator and the receiver to the higher notch frequency.

(i) Tune the right-hand cavity for maximum attenuation by using procedure 5.f.

(j) Repeat steps (c) through (i) but only tune the trimmer capacitors when tuning the notches.

e. Minor "Touch-Up" Procedures (Models T1485A, AF and T1487A, AF)

(1) Method A

(a) Using the Recommended Test Equipment given for Method 1, tune the signal generator and the receiver to the duplex receive frequency.

(b) Connect the signal generator to the antenna port and the receiver to the right-hand port.

(c) Tune the right-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.

(d) Tune the signal generator and the receiver to the duplex transmit frequency.

(e) Connect the receiver to the left-hand port.

(f) Tune the left-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.

(g) Connect the receiver to the right-hand port.

(h) Tune the trimmer capacitor(s) on the right-hand cavity(s) for maximum attenuation.

(i) Tune the signal generator and the receiver to the duplex receive frequency.

(j) Connect the receiver to the left-hand port.

(k) Tune the trimmer capacitor(s) on the left-hand cavity(s) for maximum attenuation.

(2) Method B

(a) Using the Recommended Test Equipment given for Method 2, connect the equipment as shown in Figure 5.

(b) Tune the left-hand cavity(s) for a maximum power reading on the wattmeter by adjusting the tuning rod screw.

(c) Connect the equipment as shown in Figure 6.

(d) Tune the signal generator to the receive frequency.

(e) Tune the right-hand cavity(s) for a minimum insertion loss (maximum signal at the receiver) by adjusting the tuning rod screw.

(f) Connect the equipment as shown in Figure 7.

(g) Tune the trimmer capacitor(s) on the left-hand cavity(s) for maximum attenuation.

(h) Connect the equipment as shown in Figure 8.

(i) Set the local oscillator source to the exact duplex frequency separation.

(j) Tune the trimmer capacitor(s) on the right-hand cavity(s) for maximum attenuation.

f. Tuning the Notch

(1) If the Notch (Reject) Frequency is Below the Pass Frequency:

(a) Move the sliding screws as far apart as possible and then tighten the screws.

(b) Tune the trimmer capacitor for maximum attenuation at the notch frequency.

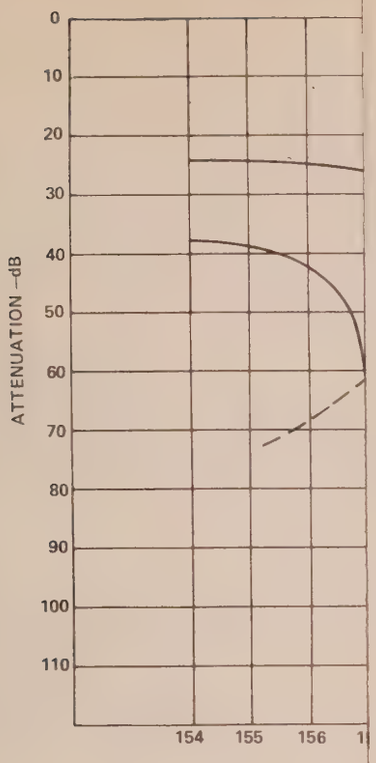
(2) If the Notch (Reject) Frequency is Above the Pass Frequency:

(a) Turn the trimmer capacitor completely counterclockwise and then clockwise two full turns.

(b) Adjust the sliding screws for maximum attenuation at the notch frequency and then tighten the screws.

(c) Tune the trimmer capacitor for maximum attenuation at the notch frequency.

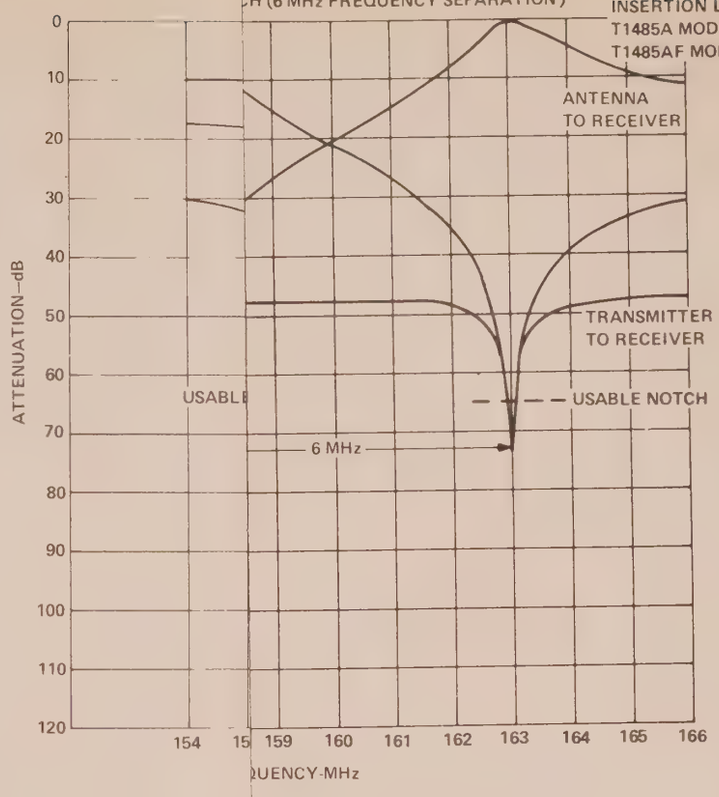
T1482A



S – REJECT DUPLEXER

CH (6 MHz FREQUENCY SEPARATION)

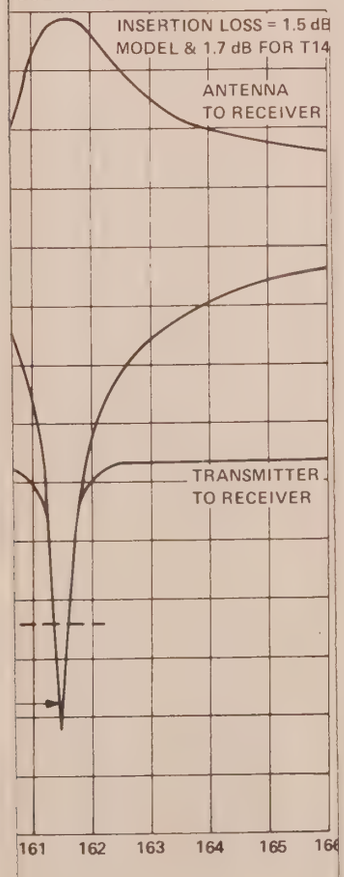
INSERTION LOSS = 0.7 dB FOR T1485A MODEL & 0.9 dB FOR T1485AF MODEL



QUENCY-MHz

CT DUPLEXER

EQUENCY SEPARATION)



EEPS-8176-O

ectivity Curves

STATION DATA

Description 68P81041E74
Installation 68P81042E41
System Audio Level Adjustments 68P81060E24
Station Maintenance 68P81042E51

TRANSMITTER

Transmitter Introduction 68P81042E88
Transmitter Interconnect Board 68P81041E44
Exciter 68P81026E66
Power Amplifier 68P81039E38
Power Control Board 68P81015E07

RECEIVER

Receiver Introduction 68P81042E89
Receiver Interconnect Board 68P81034E07
RF & I-F Board 68P81026E37
Audio & Squelch Board 68P81025E79
Audio & Power Amplifier 68P81014E97

POWER SUPPLIES

Power Supply 68P81020E44
Power Supply 68P81041E49

MISCELLANEOUS

RF Wattmeter 68P81041E76
F0 Kit 68P81042E12
Power Coupler 68P81042E11

REMOTE CHASSIS AND MODULES

Remote Control Chassis 68P81041E51
Line Driver 68P81041E48
Station Control 68P81041E39
Pilot Tone Decoder 68P81041E41
Tone Function Decoder 68P81041E42
Encoder 68P81036E36
DC Function Decoder 68P81041E43
RQS Detector 68P81041E18
RQS Line Current Generator 68P81041E17
Metering Module 68P81041E38
Sub-Audible Paging 68P81044E56

REMOTE CONTROL CHASSIS

1. DESCRIPTION

The unified remote control chassis is described in this manual section (see model chart). A unified chassis includes and interconnects the remote control chassis modules to the transmitter and receiver interconnect boards.

The remote control chassis mounts plug-in modules that perform switching functions for station operation. Nylon guide rails in the chassis align the modules with the mating connecting pins on the interconnect circuit board at the rear of the chassis.

2. APPLICATION

2.1 TONE OR DC REMOTE CONTROL

The remote control chassis, together with the associated plug-in modules, permits a station to be operated from a remote location and performs various control or operational functions for the station. Tones or dc line currents are carried over wire lines to the station remote control chassis to implement the desired type of operation. The remote control chassis and its modules convert the tones or dc line currents into switching functions to perform any or all of the operations listed in Tables 1, 2 and 3 depending on the modules used.

3. REMOVAL AND REPLACEMENT OF MODULES

Modules may be removed by simply pulling outward on the module, and may be replaced by pushing the module into its position in the panel. The modules are labelled and the mounting positions are marked on the interconnect board at the inside rear of the module housing.

CAUTION

1. Turn power off before removing or reinserting modules.
2. Never attempt to plug a module into the pins on the back of the remote control unit.
3. Always be sure of the correct module position before plugging in a module.

Technicians who service many of these stations may wish to carry spares and replace malfunctioning modules for immediate restoration of operation. The module may then be repaired at the shop and used as the next replacement spare.

NOTE

All jumper connections must be identical on modules that are removed and modules that are inserted before swapping can be successfully used as a troubleshooting technique.

Table 1. DC Commands

DC LINE CURRENT (mA)	FUNCTIONS
—2	Transmit FØ (reduced rf power output)
+2	Transmit F1 (full rf power output)

Table 2. Tone Commands

TONE FREQ. (Hz)	OPERATION
1550	Transmit F1 (full rf power output)
1450	Transmit FØ (reduced rf power output)

Table 3. Pilot Tone

TONE FREQ. (Hz)	OPERATION
2432	Function Tone Enable

parts list

PL-6451-A

DESCRIPTION
r, fixed:
80-20%; 25 V
r: (see note)
e M9701
arts
T, receiver control includes: ref.
60, 961
ex 3/8-32 x 1/2 x 3/32"; 2 used
N, tapping: 4-40 x 3/8"; 4 used
ER, lock: #3/8 int.
ACT, receptacle; 6 used
control; 2 used
, tie
NER
KET, control, riveted
T, power control includes: ref.
21, 922, Q902
KET and SOCKET, riveted
N, tapping: 6-18 x 1/2"; 2 used
ER, lock: #6 ext; 2 used
ATOR, transistor
NG, connector
NAL, 3 used
, tie
polarizing
channel element (transmitter)
N, tapping: 40-40 x 3/8"; 2 used
NER; 2 used
ubber
eyeleted includes:
R, channel element
channel element (receiver)
N, tapping: 4-40 x 3/8"; 4 used
NER, 4 used
ubber; 2 used
R, eyeleted includes:
ER, channel element
tapping: 6-20 x 5/16"; 55 used
, insulator; 3 used
T, receiver
G
exciter
ard; 18 used
rcuit board; 9 used
hassis

PL-6449-A

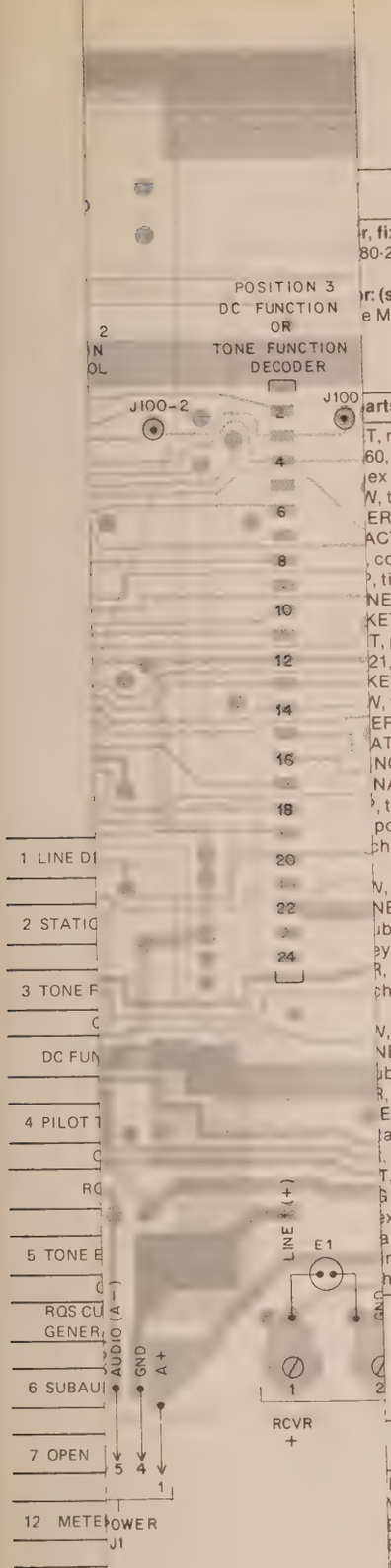
DESCRIPTION
BOARD, eyeleted includes:
N, machine: 6-32 x 5/16"; 29 used
ECTOR, male: low profile; 3 used
ECTOR, male: high profile; 2 used
NAL, 29 used
NAL, pin, male: 276 used
ACT, plug; 11 used
TOR, receptacle: 7-contact
ted tongue; 3 used
AP: 230 V; 4 used

TRN8220A Chassis and Hardware Kit — PL-6484-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		resistor:
R960,961	18-82515B50	var. 25k
		mechanical parts
	1-80775B02	BRACKET, receiver control includes: ref. items R960, 961
	2-7018	NUT, hex 3/8-32 x 1/2 x 3/32"; 2 used
	3-138162	SCREW, tapping: 4-40 x 3/8"; 4 used
	4-7698	WASHER, lock: -3/8 int.
	39-10184A24	CONTACT, receptacle; 6 used
	36-82629H02	KNOB, control; 2 used
	42-10217A02	STRAP, tie
	42-84284B01	RETAINER; 4 used
	1-80775B01	BRACKET, control riveted
	1-80775B06	COVER, channel element (transmitter) includes:
	3-138162	SCREW, tapping: 40-40 x 3/8"; 2 used
	42-84284B01	RETAINER; 2 used
	75-82902K01	PAD, rubber
	1-80775B05	COVER, eyeleted includes:
	27-82873K01	COVER, channel element

TKN6570A Cable Assembly Receiver (W101) — PL-5144-O

		CONNECTOR, plug:
J103	9-84968D01	BNC bulkhead type
P101	28-82331G01	single contact
NON-REFERENCED ITEM		
	30-83794C01	CABLE, coaxial; 17" lg.



REMOTE CONTROL CHASSIS

TCN1293A Remote Control Chassis
Interconnect Board and Chart
Motorola No. PEPS-27824-B
7/15/81-PHI

LINE DRIVER MODULE

MODEL TLN5938A

FUNCTION

Accepts and amplifies receiver audio and routes it to the output lines. Two transformers are provided. One is used for accepting the transmit audio and dc or tone control signals, and the other is used to provide line audio to the output point. A gating circuit is included which allows external control of receiver muting. Jacks located on the front panel are provided to facilitate maintenance procedures.

JACK DETAIL

REAR VIEW
(J1 - J7)

NOTES:

1. UNLESS SPECIFIED OTHERWISE, RESISTOR VALUES ARE IN OHMS AND CAPACITOR VALUES ARE IN MICROFARADS.
2. CIRCLED NUMBERS (①, ②, ETC.) INDICATE SIGNAL INPUT POINTS FOR AC VOLTAGE (V RMS) MEASUREMENTS. IN ALL CASES, THE SIGNAL GENERATOR WAS SET TO THE LEVEL INDICATED AT 1000 Hz.
3. JUMPER CONFIGURATIONS ARE GIVEN IN THE FOLLOWING CHART:

JUMPER	USAGE
JU1	NORMALLY IN, OUT FOR SPECIAL APPLICATIONS
JU2	NORMALLY IN, OUT FOR SPECIAL APPLICATIONS
JU3	NORMALLY OUT, IN FOR TONE REMOTE CONTROL
JU4	TRANSMIT ONLY STATIONS (2-WIRE SP APPLICATIONS)
JU5	IN FOR DC REMOTE CONTROL STATIONS, OUT FOR TONE REMOTE CONTROL STATIONS
JU6	IN FOR TONE REMOTE CONTROL STATIONS, MAY BE OUT FOR DC REMOTE CONTROL STATIONS
JU7	NORMALLY IN, OUT FOR SPECIAL APPLICATIONS
JU8	NORMALLY IN, OUT FOR SPECIAL APPLICATIONS
JU9	NORMALLY IN, OUT FOR SPECIAL APPLICATIONS
JU10	NORMALLY OUT, IN FOR RECEIVER LINE LEVELS < –10 dBm

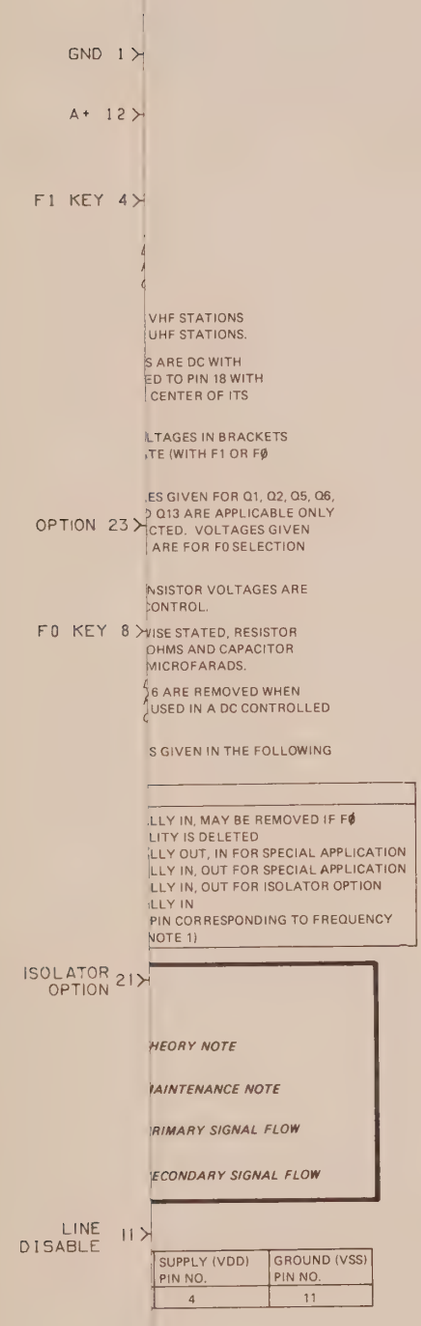
FRONT PANEL JACKS
TO CORRESPONDING POINTS
D (①, ②, ETC.)

TLN5938A LINE DRIVER MODULE

68P81041E48-B
7/15/81-PHI

STATION CONTROL MODULE

MODEL TLN5939A



FUNCTION

Provides the necessary logic and switching functions used for keying the transmitter. This module also provides local control capability.

TLN5939A STATION CONTROL MODULE

68P81041E39-B
7/15/81-PHI

MOTOROLA INC.
Communications
Group

PILOT TONE DECODER MODULE

MODEL TLN1946A

1. GENERAL

The pilot tone decoder module removes the 2432 Hz pilot tone signal from the transmit audio and converts it to a PTT signal. The decoder amplifies and distributes received function tones to the function tone decoder module. It also prevents responses to function tone signals outside of a predetermined frequency range.

2. CIRCUIT DESCRIPTION

(Refer to the Functional Diagram PEPS-28508 and Schematic Diagram PEPS-32446)

2.1 INPUT CIRCUIT

A high level, 115 millisecond pilot tone burst, received from the I/F, is applied to the module at pin 21. Prefilter L1-C2 provides selectivity and protection against undesired signals and noise. The 2432 Hz pilot tone is coupled through the prefilter, then passes through three-stage amplifier Q1, Q2 and Q3, and finally through reed driver Q4. The reed driver output signal is applied through Q23 to a *Vibrasponder* resonant reed, which acts as a precision frequency filter with very narrow bandwidth. Only 2432 Hz pilot tone signals are coupled through the resonant reed, all other frequencies are blocked. The output of the reed is applied through Q5 and Q6, the fourth and fifth amplifier.

2.2 PILOT TONE DETECTION

The pilot tone output from the fifth amplifier, Q6, is applied to pilot tone detector Q11. Q11 converts the 2432 Hz tone to a dc voltage level. The output of Q11 is applied to dc isolator Q12, biasing it into saturation. (The output of pilot tone detector inhibit Q18 is also applied to Q12, but Q18 is off at this time which does not inhibit Q12.) With Q12 saturated, push-to-talk switch Q13 also turns on, generating a logic low at its collector. PTT switch Q13 initiates the dc logic switching action and reference timing for several other circuits. Q13 switches from a logic high to a logic low upon detection of 2432 Hz high level pilot tone and remains in this state until after the pilot tone input is removed.

The output of Q13 is applied to the following points:

- output pin 14 (line push-to-talk function).
- bootstrap circuit Q15.
- function tone window stages Q16 and Q17.
- line age detector Q10.

2.3 BOOTSTRAP CIRCUIT

Bootstrap Q15 is turned off by the negative-going output from Q13 and disconnects R22 from fourth amplifier Q5 input circuit. This action affectively raises the decoder amplifier output approximately 20 dB so that the low level pilot tone (which is 20 dB lower than the high level pilot tone) output is essentially the same as was produced by the high level. This action precedes the actual arrival of low level pilot tone.

2.4 FUNCTION TONE WINDOW

An rc delay circuit (C23, R61, R62, R63, and R66) forms the negative-going output from Q13 into a 375-millisecond pulse. This negative pulse turns off Q16 and Q17, thus, generating the function tone window. The function tone window is a 375 millisecond time period during which the function tones pass through the pilot tone decoder and can be detected in the various tone control modules. The output from Q16 provides the tone gating window which allows the tones to pass through the pilot tone decoder, whereas the output from Q17 provides a decoder bias window which enables the function decoders only during the window period.

When Q16 is turned off, it disconnects the L1-C2 prefilter ground path and effectively removes the prefilter from the circuit. With the prefilter in the disconnect condition, function tones (1450 Hz and 1550 Hz) can pass through the amplifier to the function tones output (pin 16).

Simultaneously, with Q17 off, a high output is applied to function tone window output (pin 15) on the tone function decode module, this logic high output is inverted to a low level, 375-millisecond, function enable window that enables the tone control detectors.

technical writing services
1301 E. Algonquin Road, Schaumburg, Il. 60196
7/15/81-PHI
68P81041E41-B

If PTT switch Q13 turns off before the 375 millisecond time period has elapsed, Q16 and Q17 turn on immediately, ending the function tone window. Immediately following the function tone, Q24 (fast activity checker) turns on and aborts the function tone window.

2.5 ACTIVITY CHECKER AND PILOT TONE DETECTOR INHIBIT

Immediately upon application of a high level pilot tone signal, activity amplifier Q21 is turned on by each positive half of the tone signal. The inverted pulses cause activity checker Q20 to follow at the same rate and charge C25 to a positive value. This holds inverter Q19 and pilot tone detector inhibit Q18 off as long as either pilot or function tones are received. With Q18 turned off, the pilot tone detector dc output can be applied to dc isolator Q12 for normal PTT operation. The turn off of Q18 also removes the inhibit input to the gated agc detector.

2.6 FUNCTION TONE CIRCUITS

The system is now ready to receive function tones. At the end of the initial 115-millisecond pilot tone burst, a 40-millisecond function tone is sent by the I/F unit, amplified by the pilot tone decoder transistors (Q1, Q2, Q3 and Q4) and then distributed to the function decoders. If a line transmission is to be made, a low level pilot tone resumes and continues to drive transistor Q11, providing push-to-talk activation for the rest of the transmission. This pilot tone level is 20 dB lower than the initital burst, but still provides full drive to transistor Q11, because Q15 is "off" providing 20 dB of additional gain. Line PTT is not lost during the function tone burst, as inverter Q19 does not turn off until activity has been lost for at least 170 milliseconds.

2.7 AGC CIRCUITS

The line agc detector, Q10, and attenuator Q9 stages reduce the module amplifier gain upon receipt of very strong audio signals. This prevents third amplifier stage Q3 from clipping which would produce harmonics that could falsely drive the *Vibrasponder* resonant reed. Q10 samples the output of reed driver Q4 and supplies base drive to attenuator Q9 whenever the reed is overdriven. This turns on Q9 and provides a low impedance path to ground, between Q1 output and Q2 input and shunts part of the signal to ground. When line push-to-talk occurs, Q10 turns off and is removed from agc control because of the reverse bias voltage provided, via CR14 and R90, from push-to-talk switch Q13.

The gated agc detector (Q7 and Q8) is very slow acting and maintains the reed output level sufficient (with input levels as low as -55 dBm) to assure proper drive to detector Q11 and activity checker Q20. When the reed output decreases, the output of 4th amplifier Q5 reduces base drive to agc isolator Q8. This results in less drive to attenuator Q9, causing it to conduct less, thus holding the reed output level constant within the operating range.

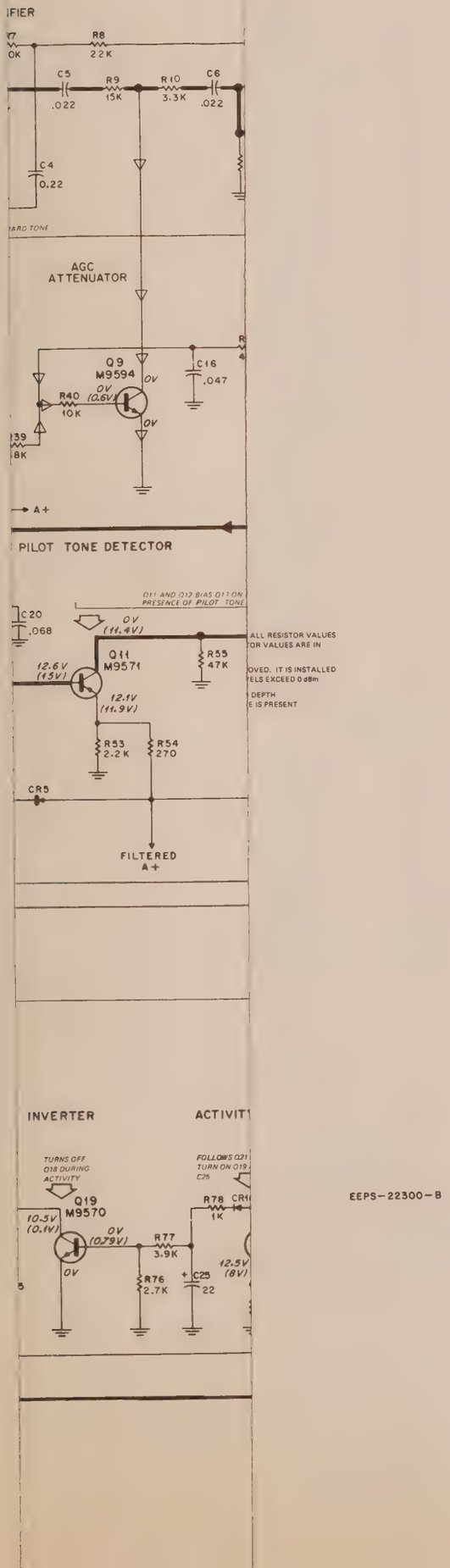
2.8 REED QUENCHING

Reed quenching stage Q14 provides rapid transmitter turn-off at the end of low level pilot tone. This quenching action is necessary because the output from the *Vibrasponder* reed decays very slowly because of its inherent high "Q". Loss of low level pilot tone causes activity checker Q20 to revert to a low output. After a 170 millisecond coupling delay, pilot tone detector inhibits Q18 inhibits dc isolator Q12, which turns off PTT line switch Q13. When Q13 turns off, its collector voltage raises positive and produces a positive input voltage spike that causes Q14 to saturate and disable the *Vibrasponder* resonant reed. The time constant is such that Q14 remains on for approximately 20 milliseconds, thus insuring that the reed has sufficient time to be disabled.

TLN1946A Pilot Tone Decoder Module
Troubleshooting Chart
Motorola No. ***CEPS-32393-O***
7/15/81-PHI

PILOT TONE DECODER MODULE

MODEL TLN1946A



EEPS-22300-B

FUNCTION

— Converts 2432 Hz Pilot Tone Signal to line PTT signal.
— Amplifies and distributes received function tones to other function decoders.
— Provides security against falsing from function tone signals outside predetermined time frame.
— Notch filter removes 2432 Hz Pilot Tone Signal from transmit audio.

MODEL BREAKDOWN

ITEM	DESCRIPTION
KLN6209A	*Vibrasponder* Resonant Reed
TLN5941A	Pilot Tone Decoder Board

Circuit Board Detail, Schematic Diagram and Parts List
Motorola No. ***PEPS-32446-O***
7/15/81-PHI

MOTOROLA INC.
Communications
Group

TONE FUNCTION DECODER MODULE

MODEL TLN5940A

1. GENERAL

The tone function decoder module converts control tones into station control functions.

2. CIRCUIT DESCRIPTION

(Refer to Functional Block Diagram PEPS-28508 and Schematic Diagram PEPS-32447.)

2.1 FUNCTION TONE DETECTION

The function tone window (high going) pulse is applied to pin 15 and enables Q3 (FØ detector) and Q4 (F1 detector).

2.1.1 F1 function tone (1550 Hz) is amplified by Q1, passes through a bandpass filter comprised of L1 and C6, and is detected by F1 tone detector (Q4). The Q4 collector goes low for the duration of the F1 tone. The low output of Q4 is applied to the station control module from F1 key output (pin 4) where it sets the F1 bistable.

2.1.2 The FØ (1450 Hz) function tone is amplified by Q1, passes through a bandpass filter comprised of L2 and C5, and is detected by FØ tone detector (Q3). The Q3 collector goes low for the duration of the FØ tone. The low output of Q3 is applied to the station control module from FØ key output (pin 8) and sets the station control module FØ bistable.

2.2 TALK-BACK-TONE GENERATION

The tracking edge of the function tone window pulse triggers the TBT monostable (U3A). U3A-5 goes high for 50 msec. This high pulse is applied to U2A-2 and U2D-12. When the base station transmitter reaches full power (before the end of the function tone window) the power detect input (pin 6) goes high. This high going pulse inverted by U2D and U2B, turns on Q200. Q200 enables tone gate (Q10) for 50 msec. With Q10 enabled, the oscillator output is coupled to amplifier Q13 and applied to talk-back-tone output (pin 2).

2.3 POWER ALARM TONE GENERATION

Power alarm tone generation functions during initial key-up and during the subsequent transmission. When a key-up command is sent from the terminal, if the transmitter power is below a threshold level (determined by R103 in the station control module) power detect input (pin 6) is low, gate U2A is enabled, and a low from U2C-10 triggers alarm monostable (U3B). A 7.5 sec. (nominal) pulse from U3B-9 is inverted by U2D and U2B turning on Q200 thereby enabling tone gate Q10. The oscillator output is amplified by Q13, and applied to pin 2.

NOTE

In the FØ mode the power alarm does not function.

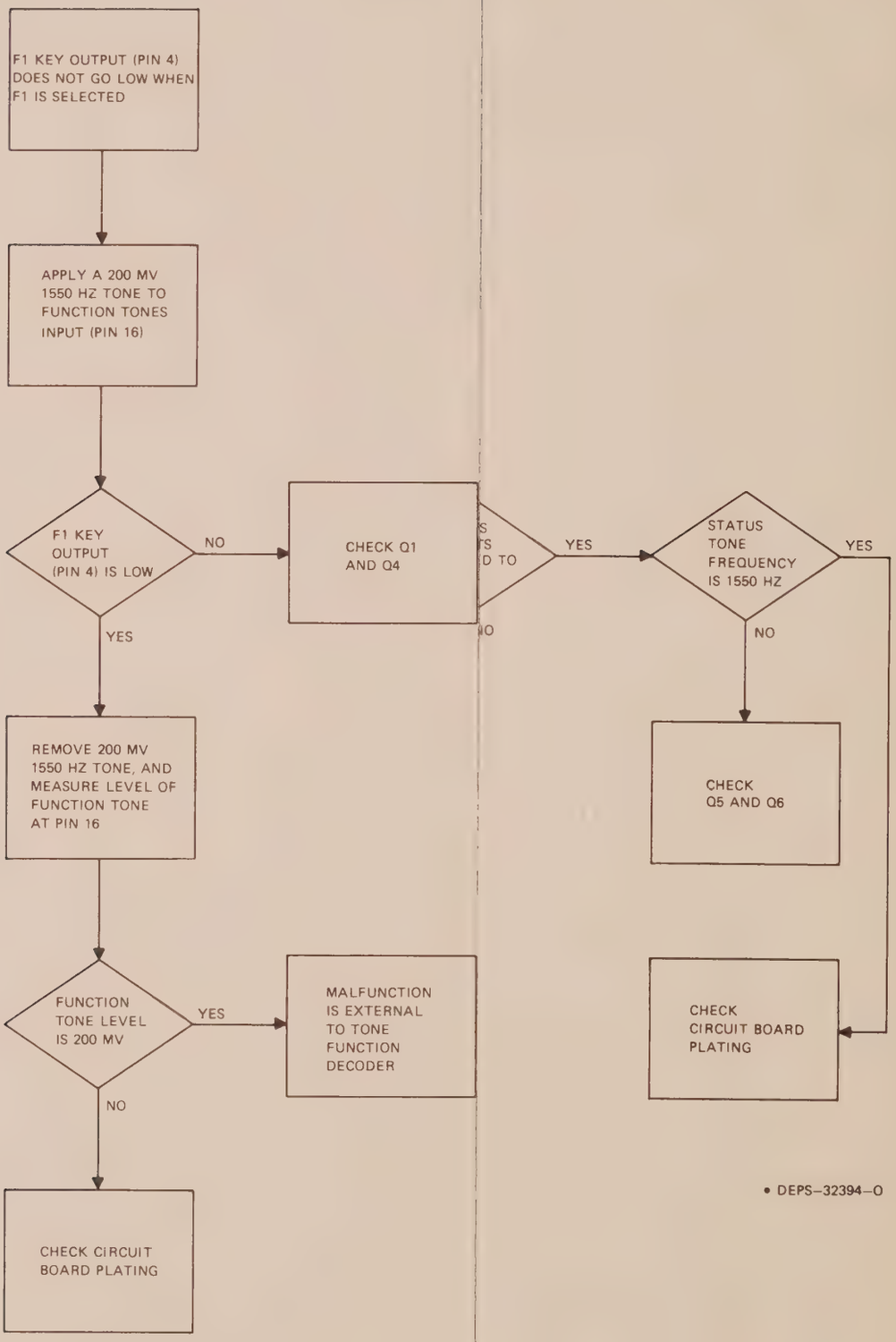
2.2 TALK-BACK-TONE ALARM GENERATION

During FØ operation, a high is applied to pin 3 (FØ stored), Q5 is turned on, C14 is switched into the oscillator, and the oscillator frequency is 1450 Hz. The TBT decoder module (Time Remote Control Interface Unit) generates the TBT alarm if no TBT is sent, or if the wrong frequency TBT is sent.

2.4 IDLE TONE DETECTION

Idle tone is normally sent by the terminal when the base stations are in the F1 mode, and no conversation is present. The basic idle tone detector is comprised of amplifier Q100, clipper Q101, buffer Q102, detector Q103, and switch Q104. When idle tone is detected the collector of Q106 goes high, enabling the status report tone astable U1. U1 generates a low going pulse of 83 msec duration, every 2 seconds. This low going pulse is inverted by U2B, and Q200. Q200 enables tone gate Q10. The oscillator output is amplified by Q13 and applied to pin 2. If 2 or more status reports are missed, the TBT decoder module will generate an alarm.

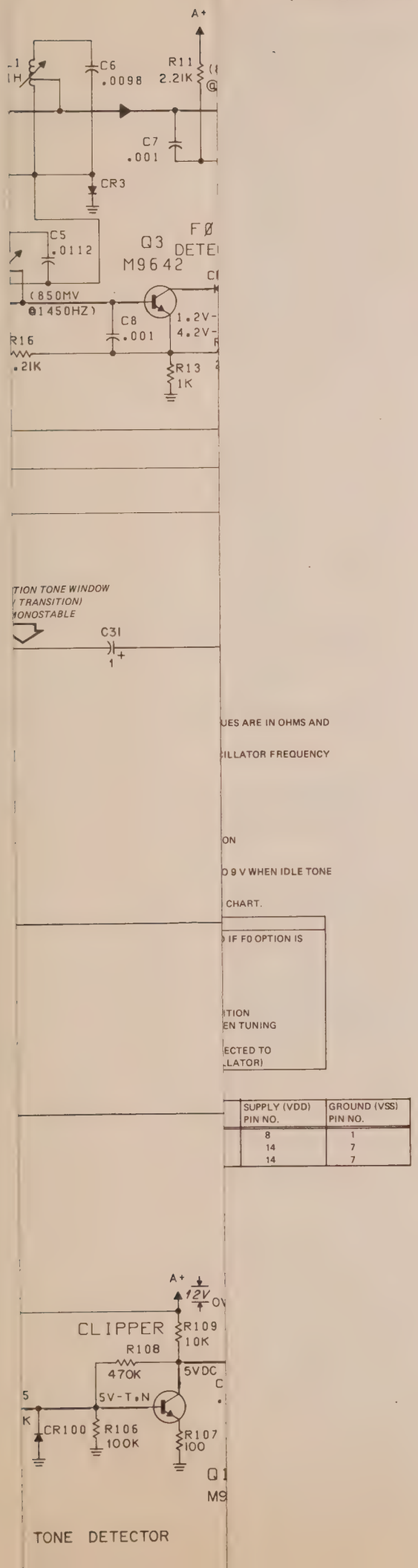
technical writing services
1301 E. Algonquin Road, Schaumburg, Il. 60196


F1 KEY OUTPUT (PIN 4) DOES NOT GO LOW WHEN F1 IS SELECTED
APPLY A 200 MV 1550 HZ TONE TO FUNCTION TONES INPUT (PIN 16)
F1 KEY OUTPUT (PIN 4) IS LOW
NO
CHECK Q1 AND Q4
YES
STATUS TONE FREQUENCY IS 1550 HZ
YES
NO
YES
REMOVE 200 MV 1550 HZ TONE, AND MEASURE LEVEL OF FUNCTION TONE AT PIN 16
CHECK Q5 AND Q6
FUNCTION TONE LEVEL IS 200 MV
YES
MALFUNCTION IS EXTERNAL TO TONE FUNCTION DECODER
CHECK CIRCUIT BOARD PLATING
NO
CHECK CIRCUIT BOARD PLATING
• DEPS–32394–O

TLN5940A Tone Function Decoder
Troubleshooting Chart
Motorola No. ***BEPS-32394-O***
7/15/81-PHI

TONE FUNCTION DECODER MODULE

MODEL TLN5940A



FUNCTION

Converts control tones into station control functions:

- 1550 Hz — transmit F1 (full power)
- 1450 Hz — transmit FØ (reduced power)

PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Circuit Board Detail, Schematic Diagram, and Parts List
Motorola No. ***PEPS-32797-O***
7/15/81-PHI

TLN5940A TONE FUNCTION DECODER MODULE

"SPECTRA TAC" ENCODER MODULE

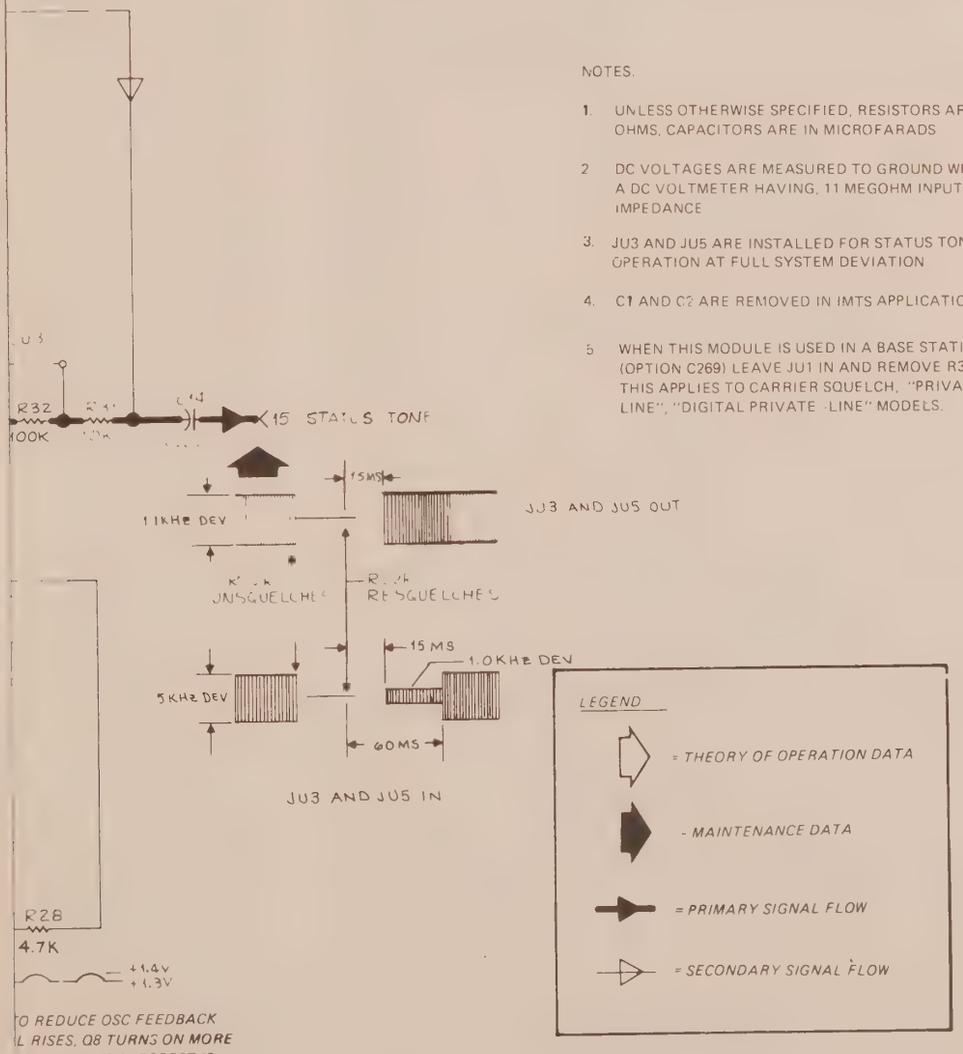
MODEL TRN6085B-1

AGE TABLE

USAGE
IN FOR CARRIER SQUELCH, OUT FOR PL SQUELCH (NORMALLY IN)
OUT FOR STATUS TONE OPERATION AT 2375 Hz. IN IMTS SYSTEMS, (NORMALLY IN)
NORMALLY OUT (SEE NOTE 3).
IN FOR STATUS TONE OPERATION AT 1950 Hz. (NORMALLY OUT)
NORMALLY OUT (SEE NOTE 3)

FUNCTION

Provides 2175 Hz status tone when receiver is squelched. Also provides test tones for line equalization.



NOTES.

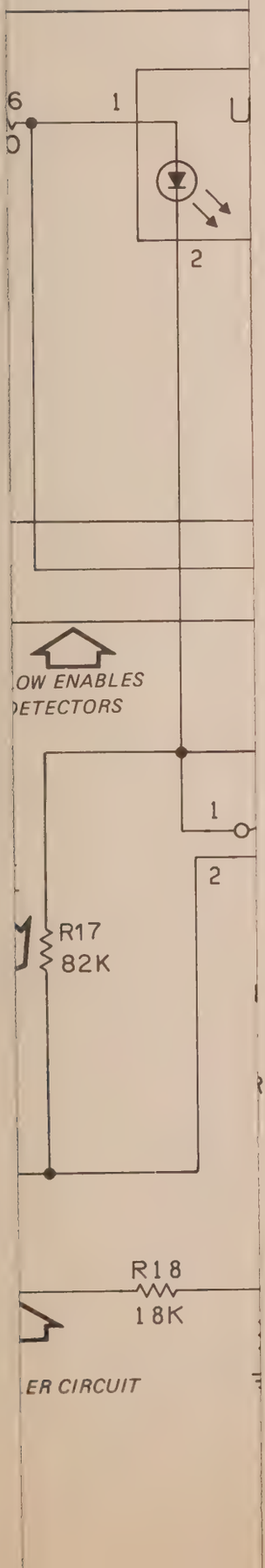
1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, CAPACITORS ARE IN MICROFARADS
2. DC VOLTAGES ARE MEASURED TO GROUND WITH A DC VOLTMETER HAVING, 11 MEGOHM INPUT IMPEDANCE
3. JU3 AND JU5 ARE INSTALLED FOR STATUS TONE OPERATION AT FULL SYSTEM DEVIATION
4. C1 AND C2 ARE REMOVED IN IMTS APPLICATIONS
5. WHEN THIS MODULE IS USED IN A BASE STATION, (OPTION C269) LEAVE JU1 IN AND REMOVE R33 THIS APPLIES TO CARRIER SQUELCH, "PRIVATE LINE", "DIGITAL PRIVATE LINE" MODELS.

TO REDUCE OSC FEEDBACK
L RISES, Q8 TURNS ON MORE
RE FEEDBACK. EFFECT IS
T LEVEL CONSTANT WITH OSC
NGE

68P81036E36-E
7/15/81-PHI

DC FUNCTION DECODER MODULE

MODEL TLN5943A



FUNCTION

Converts dc line currents from the telephone terminal into station control functions.

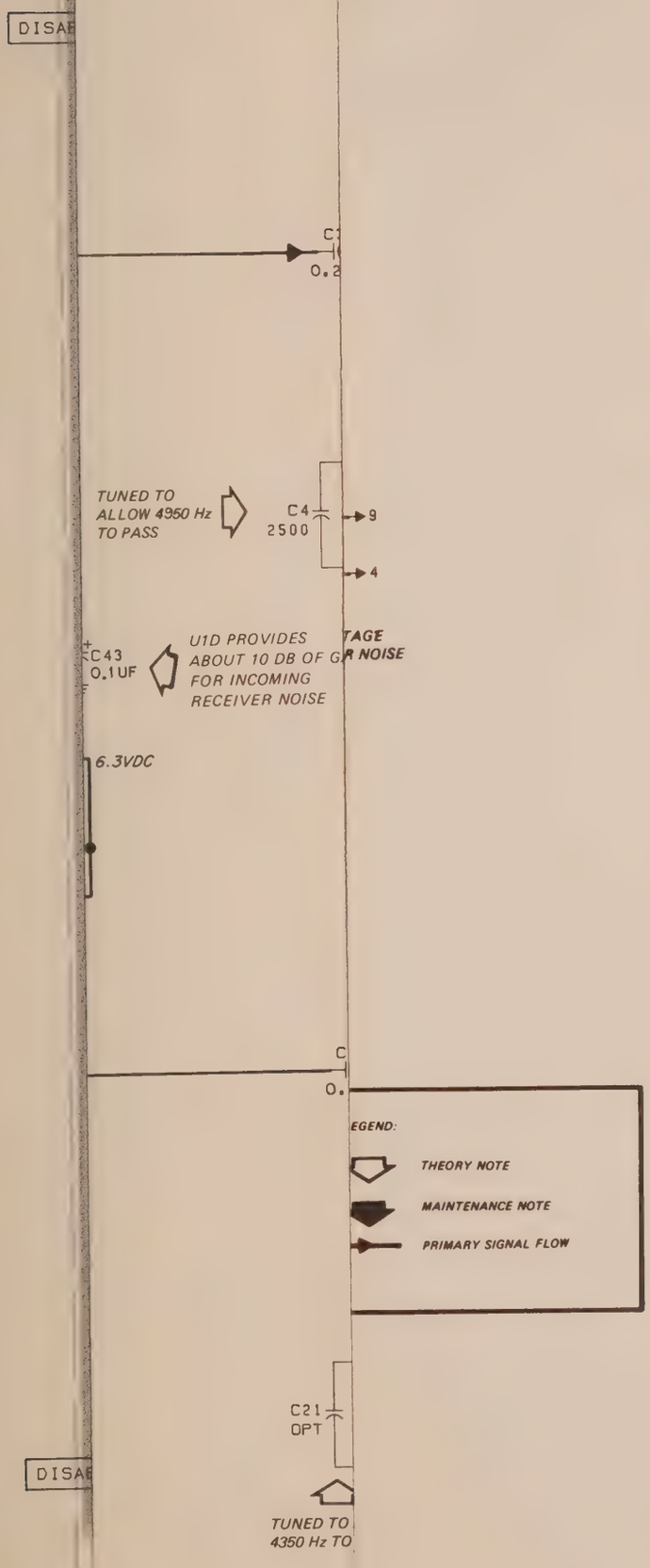
- + 2 mA transmit F1 (full power)
- -2 mA transmit FØ (reduced power)

TLN5943A DC FUNCTION DECODER MODULE

68P81041E43-B
7/15/81-PHI

RECEIVER QUALITY SIGNAL (RQS) DETECTOR

MODEL TLN5944A



FUNCTION

Samples audio noise using two sampling channels. One channel is tuned to 4200 Hz and the other is tuned to 4800 Hz. Each channel is separately amplified then summed in the output, this produces a dc output that is inversely proportional to the input.

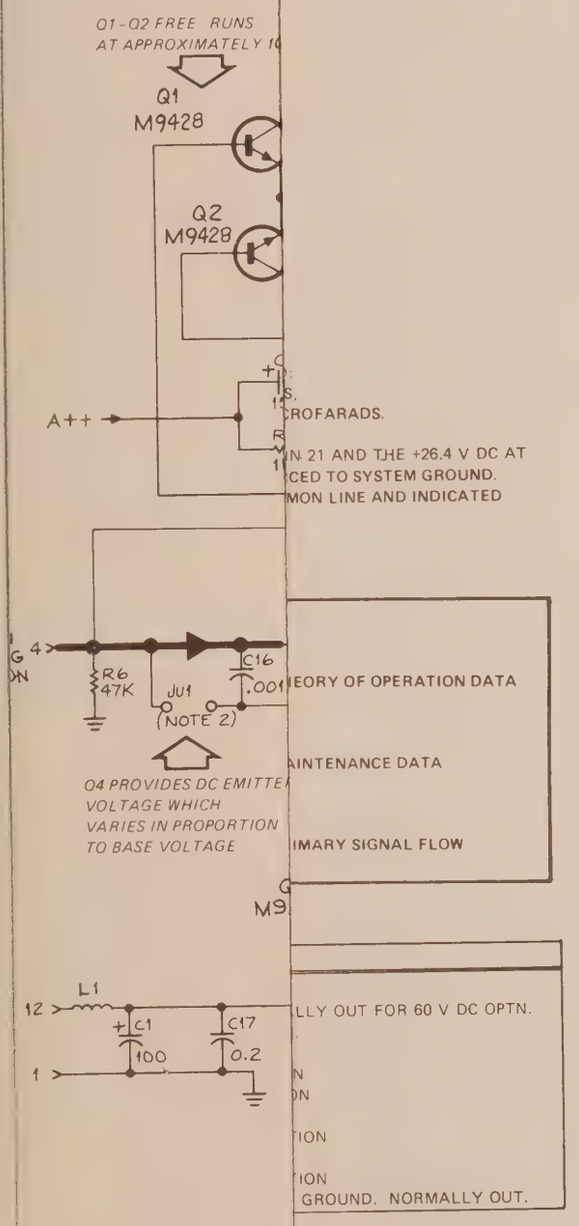
68P81041E18-B
(Sheet 1 of 2)
7/15/81-PHI

RECEIVER QUALITY SIGNAL (RQS) LINE CURRENT GENERATOR

MODEL TLN5946A

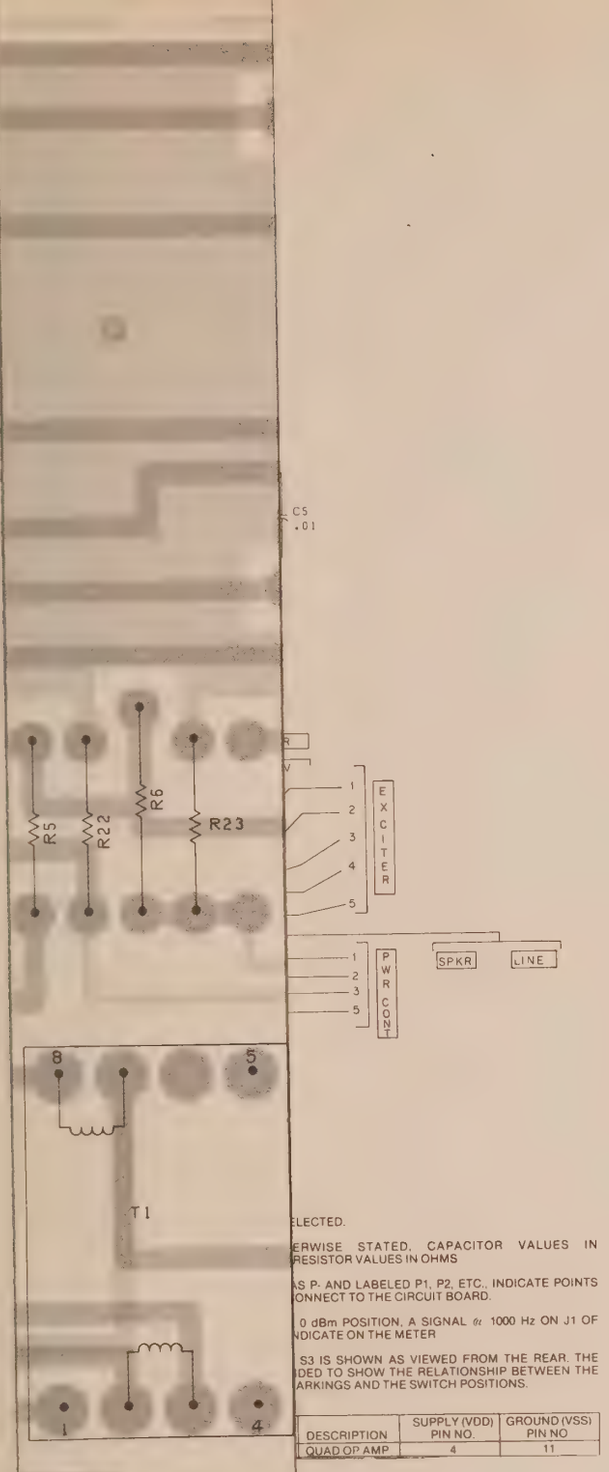
FUNCTION

Provides a direct current over the receive phone lines. This current is proportional to the dc voltage received from RQS detector.



METERING MODULE

MODEL TLN1873A



FUNCTION

Provides the operator with a means of measuring the various ac, dc and rf voltage levels associated with the equipment.

MODEL BREAKDOWN

ITEM	DESCRIPTION
TLN5956A	Metering Board
TLN5957A	Metering Chassis and Hardware
TLN5958A	Metering Support Board

68P81041E38-A
7/15/81-PHI

MOTOROLA INC.
Communications
Group

SUB-AUDIBLE PAGING MODULE (OPTIONAL)

MODEL TLN5948B

1. DESCRIPTION

This module permits sub-audible paging without requiring expensive conditioning of the telephone lines connecting the paging terminal to remote transmitters. This is done by sending the paging tones multiplied by eight to the remote transmitters and dividing these tones by eight at the remote site.

2. INSTALLATION

CAUTION

Turn power off before removing or reinserting modules.

2.1 LINE CONNECTIONS

There is a slot provided in the unified chassis for insertion of the TLN5948B Sub-Audible Paging module. When inserting this module, make sure that it fits correctly. Connect the lines carrying the paging tones from the paging terminal to TB3-17 and TB3-18 on the rear of the station interconnect board.

2.2 LEVEL ADJUSTMENTS

Step 1. Connect either an ac voltmeter or an oscilloscope to pin 3 (TP1) and pin 1 (ground) on the sub-audible paging module. Access to these points can be made at the rear of the station interconnect board.

Step 2. Apply an 800 Hz paging tone from the paging terminal. Adjust the INPUT LEVEL potentiometer (access through the front of the module) until a reading of 6.8 V p-p (2.4 V rms) is obtained at pin 3.

NOTE

The tone duration adjustment that follows, must be made after all station deviation and level adjustments are complete.

Step 3. With the 800 Hz paging tone applied as in Step 2, adjust the TONE DEVIATION potentiometer (also accessed through the front of the module) for the correct transmitter deviation. The deviation is usually 750 Hz $\pm$250 Hz.

3. CIRCUIT DESCRIPTION

The input signal at pins 16 and 17, is transformer coupled to an active low-pass filter. The signal level applied to the input of the filter is adjusted by potentiometer R2. The filter output is amplified by U1B and applied to Schmitt trigger U1A. The square wave output of the Schmitt trigger is applied to U1A. U2B in conjunction with CR3, C8, R14, and U2A forms a retriggerable one-shot that will stay low as long as there is sufficient input signal to the Schmitt trigger. The low output from the one-shot will discharge C9. If the one-shot is low for 100 msec., U3C goes high saturating Q1. This provides a ground at pins 4 and 14 of the module, which is routed to the Station Control and Tone Function Decoder modules.

A high output from U3C also enables gate U3B to pass the output of the Schmitt trigger. This series of pulses is used to clock flip-flops U4 and U5. Assume that all Q outputs of U4 and U5 are low ($\overline{Q}$ outputs are high). The first clock pulse transfers this high to the Q output of U4A. This high is NANDed with the high $\overline{Q}$ of U4B to produce a low output at gate 3A. This low is inverted by U3D and used to reset U5A and U5B. This

ensures that once every cycle, all four flip-flops are in the proper stage. The $\overline{Q}$ output of U5A is still high and the next clock pulse produces a high at both Q outputs of U4. The reset signal is removed and the next clock pulse produces a high at the Q outputs of U4 and U5B. The next clock pulse produces a high at all of the Q outputs of U4 and U5. The $\overline{Q}$ of U5A is now low and the next clock pulse will transfer the low to the Q output of U4A. The circuit acts as a divide-by-eigh counter.

The outputs of U4 and U5 are applied to a weighte resistive summing network which produces a quantiz sinewave output (see Figure 1). The quantized sinewa is applied to the active low-pass filter producing sinewave output with less than 3% distortion.

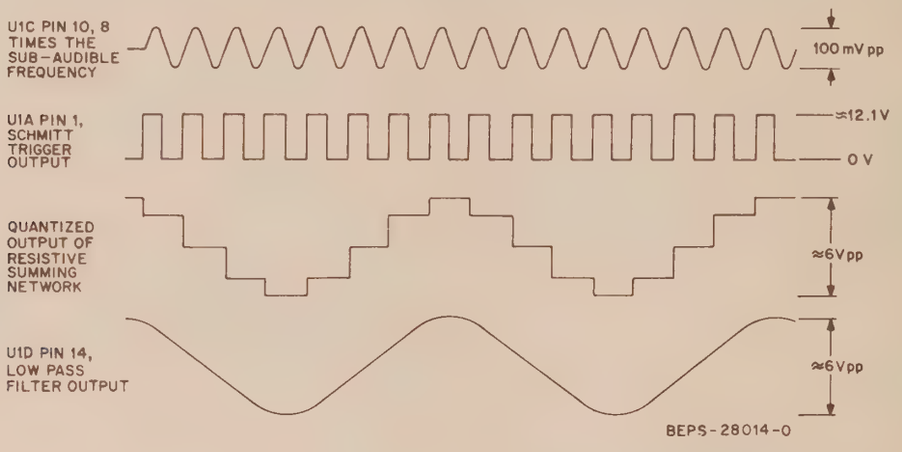
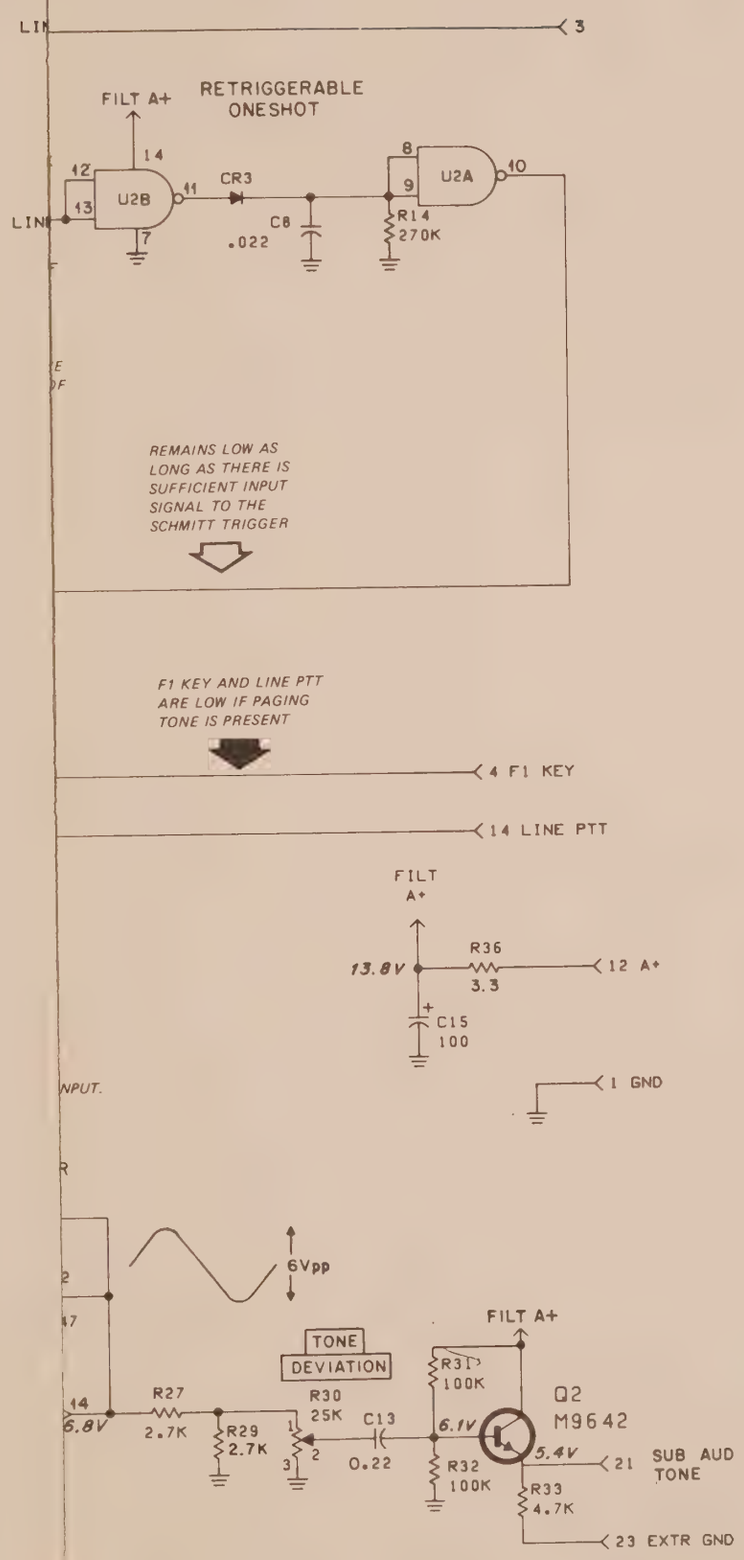

U1C PIN 10, 8 TIMES THE SUB-AUDIBLE FREQUENCY
100 mV pp
U1A PIN 1, SCHMITT TRIGGER OUTPUT
≈12.1 V
0 V
QUANTIZED OUTPUT OF RESISTIVE SUMMING NETWORK
≈6 V pp
U1D PIN 14, LOW PASS FILTER OUTPUT
≈6 V pp
BEPS-28014-0

Figure 1. Sub-Audible Paging Waveforms



TLN5948B Sub-Audible Paging Module
Schematic Diagram, Circuit Board Detail and Parts List
Motorola No. ***PEPS-29428-A***
7/15/81-PHI

MOTOROLA

USER QUESTIONNAIRE

To the User of This Instruction Manual:

Motorola is engaged in a continuous program of improving its instruction literature. We believe that you can aid us in this program, so that we in turn can better help you service our equipment. To foster these aims, would you please answer the following questions:

SCHEMATIC DIAGRAMS AND CABLING DIAGRAMS

1. ☐ Are accurate and easy to follow
2. ☐ Contain minor errors
3. ☐ Contain major errors
4. ☐ Are difficult to follow

If you have checked any box except 1, please tell us what schematic diagrams, or portions thereof, were at fault, or enter other comments.*

_____

_____

TEXT

1. ☐ Easy to follow — helps to service equipment
2. ☐ Would like more information on*

_____

_____

3. ☐ Some instruction sections are too long or superfluous such as*

_____

_____

4. ☐ Other comments*

_____

_____

_____

(continued on reverse side)

TAPE & MAIL
NOTICE: Postal Regulations Prohibit Staples.
Please use tape.

68P85901D80-L

7/12/79

PARTS LIST

1. ☐ Are complete and accurate
2. ☐ Would like more information as follows*

_____

_____

ILLUSTRATIONS IN GENERAL

1. ☐ Are complete and accurate
2. ☐ Want more illustrations such as*

_____

_____

3. ☐ Some are superfluous such as*

Second Fold

_____

_____

Second Fold

The name of my instruction manual is:

Tear out page at dotted line

_____

The part number of my instruction manual is:

_____

(This number will be found on the cover or on the title page)

My name is _____

Company _____

Address _____

City _____ State _____ Zip _____

Date _____

Phone No. (include area code) _____

*Whenever possible, give complete model number of equipment, and part number of diagram or part number of instruction section. **This information is important.**

Please fold carefully so that bar pattern at top center of envelope can be read by postal optical scanner.

First Fold

First Fold

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 75 ROSELLE, ILLINOIS

POSTAGE WILL BE PAID BY ADDRESSEE

MOTOROLA, INC.
SERVICE PUBLICATIONS DEPT.
1301 E. Algonquin Road
Schaumburg, Illinois 60196

PLEASE TAPE CLOSED BEFORE MAILING

MOTOROLA INC.

instruction manual revision

general

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

instruction manual affected:

Service, Owner's, and Operator's manuals for Mobile, Base Station, Marine, and Microwave and Rural Telephone RF Equipment

revision details:

The new OSHA safety information provided below supersedes any similar information already included in the instruction manual. File this manual revision directly under the front cover of the manual.

GENERAL SAFETY INFORMATION

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard which applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station, microwave, and rural telephone rf equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Refer to the appropriate section of the product service manual for additional pertinent safety information.

PULSAR
IMTS Base Stations
150.8-160 MHz 40-100 Watts
DC and Tone Control Models

68P81033E15-A